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Volume II
Rocky Mountain Arsenal

LITIGATION TECHNICAL SUPPORT AND SERVICES

ROCKY MOUNTAIN ARSENAL

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CHEMICAL INDEX

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Primary Name: **NP gel**

Synonym: Incendiary oil; Thickened gasoline; gel

CAS RN: Not available

Formula: Not available, mixture of napalm (naphthenic acid, coconut fatty acids, oleic acid) thickener and gasoline.

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 36-12 (65, p. 7); CAR, Site 36-17 (66 pp. 3, 13, 14, 23, 33); CAR, Section 36 - Nonsource Area (67, p. 10); CAR, Site 36-6 (108, p. 7); CAR, Site 36-9 (109, p. 7); CAR, Section 8 - Nonsource Area (116, p. 10); CAR, Site 32-5 (121, p. 9); CAR, Site 32-6 (122, p. 10).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: NP gel causes combustion of flammable materials and thermal damage or degradation of nonflammable materials. Unburned NP would be detected through analysis of the standard constituents of gasoline (benzene, toluene, xylenes, and aliphatic hydrocarbons of carbon numbers 5

through 9). The gel fraction would be analyzable through hydrolysis and analysis of fatty acid monomers.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 49, 65, 66, 67, 108, 109, 116, 121, 122

Primary Name: **Naphtha**

Synonym: Petroleum distillate; Mineral Spirits; Petroleum Spirits

CAS RN: 8030306

Formula: Not applicable, hydrocarbon mixture with limited boiling range.

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 36-9 (109, p. 7).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Naphtha composed of light (low boiling) paraffinic hydrocarbons with fate regulated by these hydrocarbons. Insoluble in water.

Toxicity: Toxicity score, 1 (RTECS).

Included on target list(s): No

References: 10, 31, 128

Primary Name: Nitrate

Synonym:

CAS RN: 14797558

Formula: NO_3

Information sources: Not assigned

History of use, production, disposal & quantities: Assessment of Contaminant Migration from Potential Contamination Sources (3).

Monitoring history: Small concentrations at Well #81A (Section 36) and Well #65A (NW of Basin A perimeter, Section 35).

Environmental fate: Nitrate can result from disposal of almost any nitrogen-containing organic compounds.

Toxicity: Toxicity score, not rated.

Included on target list(s): Ground-Water

References: 3, 21

Primary Name: Nitric acid

Synonym: Aqua fortis; azotic acid; hydrogen nitrate, fuming

CAS RN: 7697372

Formula: HNO_3

Information sources: Shell/Army

History of use, production, disposal & quantities: CAR, Site 36-17 (66, p. 28); CAR, Site 1-5 (70, p. 11); Site 26-6 (78, p. 16); Site 30-6 (105, p. 10).

Monitoring history: Nitrate is included in standard water quality monitoring.

Environmental fate: Nitric acid contributes nitrate ion to water and soil.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 1, 10, 31, 66, 70, 78, 105, 128

Primary Name: **Nitric acid/Sulfuric acid (Mixed)**

Synonym:

CAS RN: 7697372 (nitric acid), 7664939 (sulfuric acid)

Formula: HNO_3/H_2SO_4

Information sources: Army/Shell

History of use, production, disposal & quantities: History of Pollution Sources and Hazards at RMA (10).

Monitoring history: Nitrate and sulfate are included in standard water analysis.

Environmental fate: Fate not documented.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 10, 29, 31, 52, 53, 128

Primary name: Nitrite

Synonym:

CAS RN: 14797650

Formula: NO_2^-

Information sources: Not assigned

History of use, production, disposal & quantities: No nitrite salts reported in use or disposal.

Monitoring history: Included in Basin F fluid analysis. Small concentrations detected in Well #81A (Section 36) and Well #65A (NW of Basin A perimeter).

Environmental fate: Included as part of natural nitrogen cycle components in water.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 21, 31

Primary Name: **N-Nitromethylamine**

Synonym: N-Nitromethanamine

CAS RN: 589572

Formula: $CH_4N_2O_2$

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 16); CAR, Hydrazine Blending and Storage Facility (126, pp. 1-13).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Fate not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 31, 43, 78, 126

Primary Name: **4-Nitrophenol**

Synonym: p-Nitrophenol

CAS RN: 100027

Formula: $C_6H_5NO_3$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Only 2% biodegradation (by Pseudomonas Bacteria) of 200 ppm solution in 48 hours. Degraded in soils by Pseudomonas Bacteria, $t_{1/2}$ less than 6 months. Solubility, 16g/L at 25° C.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 1, 27, 31, 37, 41, 128

Primary Name: **4-Nitrophenol, sodium salt**

Synonym: Sodium p-nitrophenolate; PNSP

CAS RN: 824782

Formula: $C_6H_5NO_3Na$

Information sources: Shell

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 17).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Degraded by Pseudomonads in soil, $t_{1/2}$ less than 6 months.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 1, 10, 27, 78

Primary name: **p-Nitrophenyl diethylphosphate**

Synonym: Diethyl-p-nitrophenyl phosphate

CAS RN: 311455

Formula: $C_{10}H_{14}NO_6P$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: No information found.

Environmental fate: Solubility, 2.4g/L at 25° C.

Toxicity: Toxicity score, 4 (RTECS).

Included on target list(s): No

References: 27, 31, 37, 128

Primary name: **Nitrous acid, ammonium salt**

Synonym: Ammonium nitrite

CAS RN: 13446485

Formula: NH_4NO_2

Information sources: Shell

History of use, production, disposal & quantities: Shell Response to US Interrogatory #15 (44).

Monitoring History: Not included in environmental monitoring program.

Environmental fate: Explodes at 60-70° C. Very soluble in water.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 42, 44

Primary Name: **Octachlorocyclopentene**

Synonym: Perchlorocyclopentene; OCCP

CAS RN: 706785

Formula: C_5Cl_8

Information sources: Shell

History of use, production, disposal & quantities: CAR, Sites 1-13 and 2-18 (73, p. 19).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Chemical characteristics are consistent with low aqueous solubility and resistance to biodegradation.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 42, 43, 44, 49, 73

Primary Name: 1,4-Oxathiane

Synonym: p-Thioxane

CAS RN: 15980151

Formula: C_4H_8SO

Information sources: Army

History of use, production, disposal & quantities: HCIC Report: Literature Reviews on 54 RMA On-Post Contaminants (3).

Monitoring history: Detected in a soil sample at Site 20 (Section 6), old toxic storage yard, where an undated mustard spill occurred.

Environmental fate: Solubility, 20,000 mg/L at 25° C.

Toxicity: Toxicity score, 2 (Mayhew and Muni, 1986).

Included on target list(s): Ground-Water and Soil

References: 3, 30, 31, 133

Primary name: 3-Oxo-butanoic acid

Synonym: Acetoacetic acid

CSA RN: 541504

Formula: $C_4H_6O_3$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in monitoring program due to environmental instability.

Environmental fate: Miscible in water. Easily biodegraded. Strong but unstable acid.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 27, 37

Primary name: 2,2'-Oxybisethanol

Synonym: Diethylene glycol

CAS RN: 111466

Formula: $C_4H_{10}O_3$

Information sources: Not assigned

History of use, production, disposal & quantities: No information located.

Monitoring history: Tentatively identified as nontarget analyte in RI soil program.

Environmental fate: Solubility, 100,000 mg/L at 25° C. Degrades at a moderate rate.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 31, 59, 128

Primary Name: **Oxychlordane**

Synonym: 2,5-Methano-2H-indeno[1,2-b]oxirene, 2,3,4,5,6,6a,7,7-octachloro-1a,1b,5,5a,6,6a-hexahydro-(1a-alpha,1b-beta,2-alpha,5-alpha,5a-beta,6-beta,6-alpha)

CAS RN: 27304138

Formula: $C_{10}H_4Cl_8O$

Information sources: Lessee prior to Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Estimated solubility, less than or equal to 1 mg/L. $T_{1/2}$ in soil greater than 5 years.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 27

Primary name: **Pentachloroacetophenone**

Synonym: 2',3',4',5',6'-Pentachloroacetophenone; Dichloroacetyl-2,4,5-trichlorobenzene

CAS RN: Not available

Formula: $C_8H_3Cl_5O$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Stable; slow degradation by microorganisms, $t_{1/2}$ 6 months to 5 years. Slightly soluble.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 1, 10, 27, 31, 42

Primary name: **Pentachlorobenzene**

Synonym:

CAS RN: 608935

Formula: C_6HCl_5

Information sources: Not assigned

History of use, production, disposal & quantities: No information located.

Monitoring history: Tentatively identified as nontarget analyte in RI soil program.

Environmental fate: Solubility, 0.24 mg/L at 22° C.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 31, 41, 128

Primary name: **Pentachlorophenol**

Synonym:

CAS RN: 87865

Formula: C_6Cl_5OH

Information sources: Not assigned

History of use, production, disposal, & quantities: Shell Response to US Interrogatory #15 (44).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Slightly soluble in water (8 mg in 100 ml), freely soluble in alcohol and ether. Slowly biodegrades in soil.

Toxicity: Toxicity score, 4 (RTECS). EPA carcinogenic classification, D (not classified).

Included on target list(s): No

References: 31, 37, 44, 54, 56, 128

Primary name: **2-Pentanone**

Synonym: Ethyl acetone

CAS RN: 107879

Formula: $C_5H_{10}O$

Information sources: Not assigned

History of use, production, disposal & quantities: No information located.

Monitoring history: Tentatively identified as nontarget analyte in RI soil program.

Environmental fate: Colorless liquid. Solubility, 43,000 mg/L. Vapor pressure, 12 mm at 20° C. Miscible with alcohol.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 31, 59, 128

Primary name: **Peroxyacetic acid**

Synonym: Peracetic acid

CAS RN: 79210

Formula: $C_2H_4O_3$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Miscible in water. Decomposes in contact with oxidizable material to acetic acid. Strong oxidizing agent.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 27, 31, 37, 128

Primary Name: **Peroxybenzoic acid**

Synonym: Perbenzoic acid

CAS RN: 93594

Formula: $C_7H_6O_3$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Not stable in soil and water. Very sparingly soluble in water.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 27, 31, 37

Primary name: **Petroleum spirits**

Synonym: Mineral spirits

CAS RN: 8030306

Formula: Volatile hydrocarbon mixture

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27); Memorandum: Chemical Spills in Shell Leasehold (29).

Monitoring history: No information found.

Environmental fate: Boiling range to ca. 90° C. Slightly water soluble.

Toxicity: Toxicity score, 1 (RTECS).

Included on target list(s): No

References: 27, 28, 29, 31, 128

Primary name: **Phenanthrene**

Synonym:

CAS RN: 85018

Formula: $C_{14}H_{10}$

Information sources: Not assigned

History of use, production, disposal & quantities: No information located.

Monitoring history: Tentatively identified as nontarget analyte in RI soil program.

Environmental fate: Polynuclear aromatic hydrocarbon (PNA). Metabolized to 1,2-dihydroxynaphthalene. Soil systems provide better conditions than aquatic systems for biodegradation. Solubility, 0.816 mg/L at 20° C. Log octanol/water partition coefficient, 4.46.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 31, 41, 59, 128

Primary name: **Phenolics**

Synonym: Phenol; Hydroxybenzene; carbolic acid; phenic acid; phenyl hydroxide

CAS kN: Not applicable

Formula: Includes phenols

Information sources: Not assigned

History of use, production, disposal & quantities: CAR, Section 8 - Nonsource Area (116, p. 10).

Monitoring history: Included in ground-water monitoring program and Basin F fluid analysis. Very large concentrations in Basin F. Also low concentrations in three wells (7, 40, and 65A), which are stations in and immediately down gradient from Basin A (21).

Environmental fate: Phenolic compounds occur naturally and phenol is a common chemical and ingredient in cleaning agents. Biodegradable.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 21, 116, 128

Primary name: **alpha-phenylethyl alcohol**

Synonym: a-Methylbenzyl alcohol

CAS RN: 98851

Formula: $C_8H_{10}O$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: High resistance time (relative to other benzenes) in aerated lagoons due to conversion to acetophenone. Rapidly degraded by microorganisms, $t_{1/2}$ less than 1 month. Slightly soluble.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 1, 27, 31, 128

Primary Name: **Phosdrin**

Synonym: alpha-2-Carbomethoxy-1-methylvinyl dimethyl phosphate

CAS RN: 298011

Formula: $C_7H_{13}O_6P$

Information sources: Shell

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 17).

Monitoring history: No information found.

Environmental fate: Hydrolyzes rapidly at akaline pH and less rapidly in neutral or acidic conditions. Miscible with water.

Toxicity: Toxicity score, 4 (RTECS).

Included on target list(s): No

References: 1, 11, 27, 37, 42, 78, 128

Primary Name: **Phosgene**

Synonym: Carbonyl chloride; CG

CAS RN: 75445

Formula: $COCl_2$

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 36-17 (66, pp. 8, 18, 35); CAR, Section 36 - Nonsource Area (67, p. 11); CAR, South Plants Manufacturing Complex (68, p. 7); CAR, Sites 1-13 and 2-18 (73, p. 8); CAR, Chemical Sewers - North Plants and South Plants (90, p. 9); CAR, Site 30-6 (105, p. 12); CAR, Site 31-7 (120, p. 15); CAR, North Plants (127, pp. 11, 25).

Monitoring history: No information found.

Environmental fate: Spontaneously reacts with water and decomposes. Presence likely unless in sealed containers. Vapor pressure, 1.6 atm at 20° C. Solubility, decomposes.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

Reference: 2, 10, 18, 27, 31, 41, 66, 67, 68, 73, 90, 105, 120, 127, 128

Primary Name: **Phosphoric acid**

Synonym:

CAS RN: 7664382

Formula: H_3PO_4

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: No information found.

Environmental fate: Strong mineral acid miscible in water.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 27, 31, 128

Primary Name: **Phosphoric acid, 2,2-dichloroethenyl methyl octyl ester**

Synonym: Vincophos; SD 15803

CAS RN: 17196882

Formula: $C_{17}H_{21}O_4PCl_2$

Information sources: Shell

History of use, production, disposal & quantities: Shell Responses to Interrogatories #13 and #14 (46, 47).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 46, 47

Primary name: **Phosphoric acid, diethyl ester**

Synonym: Diethyl phosphate

CAS RN: 598027

Formula: $C_4H_{11}O_4P$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: No information found.

Environmental fate: Insoluble.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 27

Primary name: **Phosphoric acid, tributyl ester**

Synonym: Butyl phosphate

CAS RN: 126738

Formula: $C_{12}H_{27}O_4P$

Information sources: Not assigned

History of use, production, disposal & quantities: No information located.

Monitoring history: Tentatively identified as nontarget analyte in RI soil program.

Environmental fate: 1 ml dissolves in 165 ml water.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 59, 128

Primary name: **Phosphoric acid, triphenyl ester**

Synonym: Phenyl phosphate

CAS RN: 115866

Formula: $C_{18}H_{15}O_4P$

Information sources: Not assigned

History of use, production, disposal & quantities: No information located.

Monitoring history: Tentatively identified as nontarget analyte in RI soil program.

Environmental fate: Insoluble in water, but soluble in benzene, chloroform, ether, acetone. Stable and fireproof.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 59, 128

Primary Name: **Phosphorus**

Chemical name: Phosphorus, Red; Phosphorus, White

CAS RN: 7723140

Formula: P_4 (white); P (red)

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 36-17 (66, pp. 8, 19); CAR, Section 36 - Nonsource Area (67, p. 11); CAR, Sites 1-13 and 2-18 (73, p. 8); CAR, Site 2-14b (77, p. 9); CAR, Site 26-6 (78, p. 17); CAR, Section 35 - Uncontaminated (80, pp. 10, 13, 14); CAR, Sanitary Sewer - South Plants (89, pp. 14, 18); CAR, Site 19-1 (95, p. 8); CAR, Site 20-1 (97, p. 8); CAR, Site 29-1 (100, p.8); CAR, Site 30-2 (102, p. 8); CAR, Site 30-6 (105, pp. 10, 12); CAR, Site 36-14 (110, p. 12); CAR, Section 5 - Nonsource Area (114, p. 15); CAR, Section 6 - Nonsource Area (115, p. 27); CAR, Section 8 - Nonsource Area (116, p. 10); CAR, Section 9 - Nonsource Area (117, p. 10); CAR, Site 32-5 (121, p. 10); CAR, Site 32-6 (122, p. 10); CAR, Army Spill Sites (125, p. 22).

Monitoring history: No information found.

Environmental fate: White phosphorus grenade burial pit located in the center of Section 9. Heat may cause reversion of red phosphorus to yellow phosphorus which is toxic and spontaneously flammable upon contact with air. Vapor pressure, 0.181 mm (white). Solubility, 1 part/300,000 parts water (white).

Toxicity: Toxicity score, 4, (RTECS).

Included on target list(s): No

References: 2, 10, 18, 25, 31, 38, 39, 40, 52, 66, 67, 73, 77, 78, 80, 89, 95, 97, 100, 102, 105, 110, 114, 115, 116, 117, 121, 122, 125, 128

Primary name: **Photodieldrin**

Synonym: 1,1,2,3,3A,7A-Hexachloro-5,6-epoxydecahydro-2,4,7-metheno-1H-cyclopenta(A)pentalene, stereoisomer

CAS RN: 13366739

Formula: $C_{12}H_8Cl_6O$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program. See Dieldrin entry.

Environmental fate: Half life is greater than 5 years. Non-volatile. Solubility is less than or equal to 1 mg/L. May be formed in surface water or at surface of soil by sunlight. In published work on Dieldrin photolysis in the gas phase Crosby and Moilanen (Crosby, D.G., and Moilanen, K.W., "Vapor-phase Photo-decomposition of Aldrin and Dieldrin." Arch. Environ. Contam. Toxicol, 2:62, 1974) observed a Photodieldrin half-life of approximately ten days under artificial ultraviolet

light. Photodieldrin removal reactions are probably dominated by a hydroxyl-initiated oxidation reaction sequence, as are those of most organic compounds, with reaction half-lives of 0.2 to 10 days (Darnell, et al, 1970). Thus, photodieldrin would be expected to have a very short atmospheric lifetime.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 27, 31

Primary Name: **Piperazine**

Synonym: 1,4-Diethylenediamine

CAS RN: 110850

Formula: $C_4H_{10}N_2$

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 1-7 (92, p. 14).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Freely soluble in water. Absorbs water and CO_2 from air.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 31, 37, 43, 128

Primary Name: **Planavin**

Synonym: Benzeneamine,4-(methylsulfonyL)-2,6-dinitro-N,N-dipropyl-; 4-(Methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline; Nitralin

CAS RN: 4726141

Formula: $C_{13}H_{19}N_3O_6S$

Information sources: Shell

History of use, production, disposal & quantities: CAR, Site 36-7 (63, p. 12); CAR, Site 1-5 (70, p. 11); CAR, Army Spill Sites (125, p. 21).

Monitoring history: No information found.

Environmental fate: Slowly hydrolyzes to a relatively stable alcohol. $T_{1/2}$ in soil, 30 to 50 days. Solubility, less than or equal to 1 mg/L. Vapor pressure, 9.3×10^{-9} mm at 20° C.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 1, 11, 27, 37, 42, 63, 70, 125, 128

Primary Name: **Potassium**

Synonym:

CSA RN: 7440097

Formula: K

Information sources: Not assigned

History of use, production, disposal & quantities: CAR, Site 2-14b (77, p. 9).

Monitoring history: Standard element included in water quality analysis.

Environmental fate: Reacts with organic compounds with active groups.

Toxicity: Toxicity score, 3 (RTECS).

Included on target lists: Ground-Water

References: 3, 31, 37, 77, 128

Primary Name: PT-1 Mix

Synonym:

CAS RN: Not available

Formula: Not applicable, mixture

Information sources: Army

History of use, production, disposal quantities: CAR, Site 19-1 (95, p. 8); CAR, Site 20-1 (97, p. 8); CAR, Section 8 - Nonsource Area (116, p. 10); CAR, Site 32-5 (121, p. 9); CAR, Site 32-6 (122, p. 10)

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Fate not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 10, 95, 97, 116, 121, 122

Primary name: **Pyrene**

Synonym:

CAS RN: 129000

Formula: $C_{16}H_{10}$

Information sources: Not assigned

History of use, production, disposal & quantities: No information located.

Monitoring history: Tentatively identified as nontarget analyte in RI soil program.

Environmental fate: Polynuclear aromatic hydrocarbon (PNA). Sedimentary PNAs are persistent and tend to accumulate to high concentrations. Hydrolysis is not significant. Biodegradation is ultimate fate process. Solubility, 0.032 mg/L at 24° C.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 31, 41, 59, 128

NO ENTRIES

NO ENTRIES

Primary name: **Sarin**

Synonym: GB; Isoproplymethanefluorophosphonate

CAS RN: 107448

Formula: $CH_3(C_3H_7O)FPO$

Information sources: Army

History of use, production, disposal & quantities: CAR, Section 36 - Nonsource Area (67, pp. 10-12); CAR, Chemical Sewers - North Plants and South Plants (90, p. 9); CAR, Site 36-9 (109, p. 9); CAR, Site 36-19 (112, p. 9); CAR, Section 6 - Nonsource Area (115, p. 23); CAR, Site 31-7 (120, p. 12); CAR, Army Spill Sites (125, p. 28); CAR, North Plants (127, p. 10)

Monitoring history: Potential GB contaminated areas include production areas (Section 25), field operations areas (Section 30), waste disposal areas in Basins A and F, and storage areas in Sections 6 and 31. Wastes routinely treated to effect GB hydrolysis, so presence in waste unlikely. Could occur in sealed containers or demil salts. Included as an analyte in monitoring program.

Environmental fate: Persistence - evaporates at same rate as water. Miscible with and hydrolyzed by water; water removes fluorine. Hydrolysis rate, $t_{1/2}$ 7.5 hrs. at pH 1.8, 30 hours in unbuffered solutions. Very rapid hydrolysis in alkaline conditions.

Toxicity: Toxicity score, 4 (RTECS).

Included on target list(s): No

References: 2, 10, 18, 31, 32, 36, 37, 52, 67, 90, 109, 112, 115, 120, 125, 127, 128

Primary Name: **Shell nitrogen solution**

Synonym: Azodrin raffinate fertilizer - 8% nitrogen; 8-0-0-1S

CAS RN: Not available

Formula: Aqueous solution of urea and ammonium salts

Information sources: Shell

History of use, production, disposal & quantities: Shell Response to US Interrogatory #15 (44).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Miscible in water. If the solution is made strongly alkaline, ammonia will be generated. Degradation products include: CH_3CO_2, $HOCH_2CO_2$, CH_3NH_2 and various unidentified materials.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 43, 44

Primary Name: **Shell poultry spray**

Synonym:

CAS RN: Not available

Formula: The product contained Rabon Insecticide, xylene, phenol, and an emulsifier.

Information sources: Shell

History of use, production, disposal & quantities: Shell Response to US Interrogatory #13 (46).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 43, 46

Primary Name: **Sodium ion**

Synonym:

CAS RN: 7440235

Formula: Na

Information sources: Army/Shell

History of use, production, disposal & quantities: Assessment of Contaminant Migration from Potential Contamination Sources (3).

Monitoring history: Sodium detected near the north and northwestern boundary. Also detected in water table and bedrock water samples in Section 36. Relatively large concentrations of sodium in Basin F. Small concentrations at Wells #7, 40, 65A (stations in and immediately downgradient from Basin A). Also small concentrations at Well #25 (Section 23), Well #43 (Section 27), Well #60 (Section 24) and Well #105 (Section 22). Sodium chloride occurs in ground water and areas where major waste depositions occurred. Sodium analysis is performed in the monitoring program.

Environmental fate: See specific salts.

Toxicity: Toxicity score, 4 (RTECS).

Included on target list(s): Ground-Water

References: 3, 21, 25, 31, 128

Primary Name: **Sodium bicarbonate (1:1)**

Synonym:

CAS RN: 144558

Formula: $NaHCO_3$

Information sources: Army/Shell

History of use, production, disposal & quantities: CAR, Site 36-17 (66, p. 9); CAR, Site 2-8 (76, p. 13).

Monitoring history: See Sodium chloride.

Environmental fate: Soluble in 10 parts water. See also Sodium chloride.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 10, 31, 37, 42, 52, 53, 66, 76, 128

Primary Name: **Sodium bromate**

Synonym:

CAS RN: 7789380

Formula: $NaBrO_3$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: See Sodium chloride.

Environmental fate: Soluble in 2.5 parts water. Aqueous solution is neutral. See also Sodium chloride.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 27, 31, 37, 128

Primary Name: **Sodium carbonate (2:1)**

Synonym:

CAS RN: 497198

Formula: Na_2CO_3

Information sources: Army/Shell

History of use, production, disposal & quantities: CAR, Site 36-17 (66, p. 9); CAR, Section 6 - Nonsource Area (115, p. 19).

Monitoring History: No information found.

Environmental fate: Hygroscopic. Soluble in 3.5 parts water at room temperature. See also Sodium chloride.

Toxicity: Toxicity score, 1 (RTECS).

Included on target list(s): No

References: 10, 12, 31, 37, 42, 66, 115, 128

Primary Name: **Sodium chloride**

Synonym: Halite; Salt

CAS RN: 7647145

Formula: NaCl

Information sources: Army/Shell

History of use, production, disposal & quantities: CAR, Site 36-17 (66, p. 9); CAR, Site 2-8 (76, p. 14); CAR, Section 35 - Uncontaminated (80, p. 13); CAR, Section 30 - Uncontaminated Nonsource Area (106, p. 6).

Monitoring history: The monitoring program includes sodium, chloride, chlorate, sulfate, bicarbonate, fluoride, and nitrate. Any or all of the anions could have originated as sodium salts.

Environmental fate: Sodium chloride and all other sodium compounds in the RMA list dissociate in solution to produce their respective sodium cation and associated anion, chloride in this case. Analytically sodium is determined separately from the various anions. Only by calculating on the basis of the proportion of chemical equivalents of anion and cation in solution can the approximate contribution from each salt be

determined. They are also present in most natural waters. Sodium hydroxide in solution yields sodium ion and the hydroxyl effects an upward pH change. Thus, it is detected by sodium and pH analysis. Solubility, one gram dissolves in 2.8 ml water. Aqueous solution is neutral.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 8, 10, 12, 25, 31, 37, 42, 66, 76, 80, 106

Primary Name: **Sodium fluoride**

Synonym:

CAS RN: 7681494

Formula: NaF

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 17).

Monitoring history: Detected in soil and ground water.

Environmental fate: Stable in the environment. Solubility, 4.3 g/100 ml at 25° C.

Toxicity: Toxicity score, 3 (RTECS).

Included in target list(s): No

References: 8, 25, 26, 31, 37, 52, 78, 128

Primary Name: **Sodium hydroxide**

Synonym: Caustic

CAS RN: 1310732

Formula: NaOH

Information sources: Army/Shell

History of use, production, disposal & quantities: CAR, Section 36 - Nonsource Area (67, p. 11); CAR, Site 1-3 (69, p. 3); Sites 1-13 and 2-18 (73, p. 12); CAR, Site 2-8 (76, p. 14); CAR, Site 26-6 (78, p. 17); CAR, Chemical Sewers - North Plants and South Plants (90, p. 20); CAR, Process Water System (91, p. 21); CAR, Section 6 - Nonsource Area (115, p. 19); CAR, Site 31-4 (119, pp. 13, 17); CAR, Army Spill Sites (125, p. 15).

Monitoring history: Included in environmental monitoring program.

Environmental fate: $T_{1/2}$, less than 1 month. Solubility, greater than 50,000 mg/L. Rapidly absorbs CO_2 and water from air.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 1, 8, 10, 12, 25, 26, 27, 31, 37, 42, 67, 69, 73, 76, 78, 90, 91, 115, 119, 125, 128

Primary Name: **Sodium hypochlorite**

Synonym:

CAS RN: 7681529

Formula: NaClOH

Information sources: Army/Shell

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 17).

Monitoring history: No information found.

Environmental fate: In solution, hypochlorite will disproportionate yielding chlorate which has been detected in ground water. It will also decompose to produce chloride ion. Pentahydrate highly unstable.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 10, 42, 37, 53, 78

Primary Name: **Sodium methylate (alcohol mixture)**

Synonym:

CAS RN: 124414

Formula: CH_3ONa

Information sources: Shell

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 17).

Monitoring history: No information found.

Environmental fate: Hydrolyzed (fast). Rapidly degraded by microorganisms, $t_{1/2}$ less than 1 month. Decomposed in H_2O. See Sodium chloride.

Toxicity: Toxicity score, not rated.

Included on target list(s):

References: 1, 27, 42, 78

Primary Name: **Sodium nitrite**

Synonym:

CAS RN: 7632000

Formula: $NaNO_2$

Information sources: Army/Shell

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 17).

Monitoring history: No information found.

Environmental fate: Nitrite ion should be bioconverted to nitrate in the soil. Soluble in 1.5 parts cold water. Aqueous solution is alkaline. See Sodium chloride.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 10, 37, 42, 78, 128

Primary Name: **Sodium silicate**

Synonym:

CAS RN: 6834920

Formula: Na_2SiO_3

Information sources: Army

History of use, production, disposal & quantities: History of Pollution Sources and Hazards at RMA (10).

Monitoring history: Very slightly soluble in water. See Sodium Chloride.

Environmental fate: See Sodium chloride.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 10, 31, 37, 128

Primary Name: Sodium sulfate (2:1)

Synonym:

CAS RN: 7767826

Formula: Na_2SO_4

Information sources: Shell

History of use, production, disposal & quantities: CAR, Site 2-8 (76, p. 16).

Monitoring history: See Sodium Chloride.

Environmental fate: Soluble in about 3.6 parts water. See Sodium chloride.

Toxicity: Toxicity score, 1 (RTECS).

Included on target list(s): No

References: 12, 31, 37, 42, 76, 128

Primary Name: **Sodium sulfite (2:1)**

Synonym:

CAS RN: 7757837

Formula: Na_2SO_3

Information sources: Shell

History of use, production, disposal & quantities: Denver Plant Waste Disposal History (42).

Monitoring history: See Sodium chloride.

Environmental fate: Soluble in about 1.6 parts water. Aqueous solution is alkaline and dissolves sulfur. See Sodium chloride.

Toxicity: Toxicity score, 2 (RTECS).

Included on priority list(s): No

References: 12, 31, 37, 42, 128

Primary Name: **Sodium sulfonate**

Synonym: Sodium benzene sulfonate

CAS RN: Not available

Formula: $C_6H_4SO_3Na$

Information sources: Shell

History of use, production, disposal & quantities: Shell Response to US Interrogatory #15 (44); Denver Plant Waste Disposal Survey (42).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 42, 44

Primary Name: **Sodium thiosulfate**

Synonym: Hypo; hyposulfite; sodium hyposulfite

CSA RN: 7772987

Formula: $Na_2S_2O_3$

Information sources: Shell

History of use, production, disposal & quantities: Shell Responses to US Interrogatories #14 and #15 (44, 47).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Soluble in 0.5 parts water. Aqueous solution is practically neutral.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 31, 37, 42, 44, 47

Primary Name: Sulfate

Synonym:

CSA RN: 14808798

Formula: SO_4

Information sources: Army/Shell

History of use, production, disposal & quantities: Assessment of Contaminant Migration from Potential Contamination Sources (3); Rocky Mountain Arsenal Source Treatment Plan Development Study (25).

Monitoring history: Found in Section 36 and in Basin F fluid, also at the north boundary. Basins A and D samples had high sulfate concentrations. Relatively high concentrations found in wells downgradient of Basin A.

Environmental fate: See specific salts.

Toxicity: Toxicity score, not rated.

Included on target list(s): Ground-Water and Soil

References: 3, 8, 25

Primary Name: **Sulfonic acid**

Synonym:

CAS RN: Not available

Formula: SO_2OH

Information sources: Shell

History of use, production, disposal & quantities: CAR, Site 1-5 (70, p. 11).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 42, 44, 70

Primary Name: Sulfur

Synonym:

CSA RN: 7704349

Formula: S

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 36-17 (66, pp. 28, 31, 35); CAR, Site 36-16 (111, p. 8).

Monitoring history: No information found.

Environmental fate: Sulfur is stable in the environment. Slowly oxidizes to sulfate. Insoluble in water.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 10, 11, 19, 37, 66, 111

Primary Name: **Sulfur chloride**

Synonym: Sulfur monochloride

CSA RN: 10025679

Formula: S_2Cl_2

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 36-17 (66, p. 12); CAR, Sites 1-13 and 2-18 (73, p. 17).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Easily hydrolyzed to yield sulfur, hydrogen chloride, sulfur dioxide, hydrogen sulfide, sulfite, and thiosulfate.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 2, 10, 31, 37, 52, 66, 73

Primary Name: **Sulfur dichloride**

Synonym: SD

CAS RN: 10545990

Formula: SCl_2

Information sources: Army

History of use, production, disposal & quantities: History of Pollution Sources and Hazards at RMA (10).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 10, 31

Primary Name: **Sulfur dioxide**

Synonym:

CSA RN: 7446095

Formula: SO_2

Information sources: Army/Shell

History of use, production, disposal & quantities: CAR , Site 36-17 (66, p. 18).

Monitoring history: No information found.

Environmental fate: Gas. Solubility, greater than 5,000 mg/L in water to form sulfurous acid. Combines with moist air or fog to produce sulfurous acid, which slowly oxidizes to sulfuric acid. Air stripping sludge would produce calcium sulfite.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 1, 10, 27, 31, 66, 128

Primary Name: **Sulfur tetrachloride**

Synonym:

CAS RN: Not available

Formula: SCl_4

Information sources: Army

History of use, production, disposal & quantities: History of Waste Disposal Basin A and Basin F (11).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 11, 19

Primary Name: **Sulfuric acid**

Synonym: Oil of Vitriol

CSA RN: 7664939

Formula: H_2SO_4

Information sources: Shell/Army

History of use, production, disposal & quantities: CAR, Site 1-3 (69, p. 13); CAR, Site 1-5 (70, p.11); CAR, Site 1-10 (71, p. 11); CAR, Site 26-6 (78, p. 17).

Monitoring history: No information found.

Environmental fate: Neutralized in the environment to sulfate compounds, the persistence of which is highly dependent upon the cations present. Miscible with water.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 1, 10, 27, 37, 42, 69, 70, 71, 78, 128

Primary name: **Sulfuric acid, fuming**

Synonym: Oleum (65%); pyrosulfuric acid

CAS RN: 8014957

Formula: $4H_2SO_4 \quad 9SO_3$

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 36-17 (66, p. 18); CAR, Site 30-6 (105, p. 10).

Monitoring history: No information found.

Environmental fate: Oleum contributes acidity and sulfate to soil and water. RMA soil/waste solids are calcareous in many places and would neutralize acidity.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 10, 31, 66, 105

Primary Name: Sulfurous acid

Synonym:

CSA RN: 7782992

Formula: H_2SO_3

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: No information found.

Environmental fate: Oxidizes rapidly to produce sulfate ion.

Toxicity: Toxicity score, 4 (RTECS).

Included on target list(s): No

References: 27, 31, 128

Primary Name: **Sulfuryl chloride**

Synonym:

CAS RN: 7791255

Formula: SCl_2O_2

Information sources: Shell

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 17).

Monitoring history: No information found.

Environmental fate: Decomposes in H_2O to form toxic and corrosive fumes of HCl, H_2SO_4, SO_4 and SO_3. Evolves heat. Unstable to heat.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 1, 27, 29, 31, 42, 78

Primary Name: p,p-TDE

Synonym: 1,1-Dichloro-2,2-bis(p-chlorophenyl)ethane

CAS RN: 72548

Formula: $C_{14}H_{10}Cl_4$

Information sources: Lessee prior to Shell.

History of use, production, disposal & quantities: TDE is a degradation product of DDT.

Monitoring history: Found only in Section 36 (among areas sampled) at a depth of less than 2 feet, indicates lack of significant quanities of p,p-TDE.

Environmental fate: Degradation product associated with DDT. Solubility, 0.160 mg/L at 24° C.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 9, 31, 41, 128

Primary Name: **Tetrachlorobenzene**

Synonym: TCB

CAS RN: 95943 (1,2,4,5-tetrachlorobenzene)

Formula: $C_6H_2Cl_4$

Information source: Not assigned

History of use, production, disposal & quantities:
Decontamination Technology Research & Development Program for Installation Restoration at RMA (14).

Monitoring history: In synthetic waste study by Calgon for RMA (28). Tentatively identified nontarget analyte in RI soil program.

Environmental fate: Resistant to microbial decomposition. Solubility, 3.5 ppm (1,2,3,4 isomer), 2.4 ppm (1,2,3,5 isomer), 0.3 ppm (1,2,4,5 isomer).

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 14, 28, 31, 41, 128

Primary Name: **1,1,2,2-Tetrachloroethane**

Synonym:

CAS RN: 79345

Formula: $C_2H_2Cl_4$

Information sources: Not assigned

History of use, production, disposal & quantities: CAR, Chemical Sewers - North Plants and South Plants (90, p. 20).

Monitoring history: Tentatively identified nontarget analyte in RI soil and ground-water programs.

Environmental fate: Undergoes hydrolysis slowly, half life several months to a few years. No biodegradation. Vapor pressure, 5 mm at 20° C. Solubility, 2,900 mg/L at 20° C.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 31, 41, 59, 90, 128

Primary Name: 1,1,2,2-Tetrachloroethylene

Synonym: Perchloroethylene; PCE

CAS RN: 127184

Formula: C_2Cl_4

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 17).

Monitoring history: Listed as an analytical parameter in RIC data file (8). Included as an analyte in environmental monitoring program. Detected in environmental samples.

Environmental fate: Stable in the environment. Vapor pressure, 14 mm at 20° C. Aqueous solubility, 150 mg/L. Log octanol/water partition coefficient 2.60.

Toxicity: Toxicity score, 2 (RTECS). EPA carcinogenic classification, B2 (probable human carcinogen).

Included on target list(s): Ground-Water and Soil

References: 8, 20, 31, 41, 52, 54, 55, 78, 128

Primary Name: **Thickener M1**

Synonym: Napalm

CAS RN: 8031218

Formula: Not applicable

Information sources: Army

History of use, production, disposal & quantities: History of Pollution Sources and Hazards at RMA (10).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Adsorbs moisture from air rapidly making it unstable.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 10, 32

Primary Name: **Thickener M2**

Synonym: Napalm

CAS RN: 8031218

Formula: Not applicable

Information sources: Army

History of use, production, disposal & quantities: US Response to Shell Interrogatory #2/61 (49).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Not water soluble and flammability is limited when not mixed with fuels.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 49

Primary Name: **beta-Thiodiglycol**

Synonym: Thiodiglycol

CAS RN: 111488

Formula: $C_4H_{10}O_2S$

Information sources: Army

History of use, production, disposal & quantities: Problem Definition Studies on Potential Environmental Pollutants (2).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: May occur whenever mustard is in contact with water or atmospheric moisture. Miscible in H_2O.

Toxicity: Toxicity score, 2, (RTECS).

Included on target list(s): Soil

References: 2, 31, 52, 128

Primary Name: **Thionyl chloride**

Synonym: TC

CAS RN: 7719097

Formula: $SOCl_2$

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 36-17 (66, pp. 11, 18).

Monitoring history: No information found.

Environmental fate: Any spills or buried TC should evaporate or be hydrolyzed to sulfur dioxide and hydrogen chloride within a few weeks. Presence unlikely unless buried in sealed containers.

Toxicity: Toxicity score, not rated

Included on target list(s): No

References: 2, 10, 66

Primary Name: **Toluene**

Synonym: Methylbenzene; Toluol

CAS RN: 108883

Formula: C_7H_8

Information sources: Shell

History of use, production, disposal & quantities: CAR, Site 36-17 (66, p. 67).

Monitoring history: No information found.

Environmental fate: Rapid degradation by microorganisms. Aqueous solubility, 515 mg/L. Vapor pressure, 22 mm at 20° C. Component of gasoline. Biodegradation, somewhat persistent. Log octanol/water partition coefficient 2.69.

Toxicity: Toxicity score, 2 (RTECS). EPA carcinogenic classification, D (not classified).

Included on target list(s): Ground-Water and Soil

References: 1, 27, 31, 33, 41, 42, 43, 54, 56, 66, 128

Primary Name: **Tributylamine**

Synonym: Tri-n-butylamine; TBA

CAS RN: 102829

Formula: $C_{12}H_{27}N$

Information sources: Army

History of use, production, disposal & quantities: CAR, Section 36 - Nonsource Area (67, p. 11); CAR, Site 36-19 (112, p. 9); CAR, North Plants (127, pp. 12, 14, 23).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Insoluble in water, but soluble in alcohol and ether. Vapor pressure, 0.7 mm at 20° C. Log octanol/water partition coefficient, 1.52.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 10, 31, 41, 67, 112, 127, 128

Primary Name: **Trichloroacetic acid**

Synonym:

CAS RN: 76039

Formula: $C_2HO_2Cl_3$

Information sources: Not assigned.

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Vapor pressure, 1mm at 51° C. Solubility, 13,000 mg/L. Log octanol/water partition coefficient, 0.10/1.96.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 27, 41, 128

Primary Name: 2,2',4'-Trichloroacetophenone

Synonym:

CAS RN: Not available

Formula: $C_8H_5Cl_3O$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental program.

Environmental fate: Fate not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 27

Primary Name: **2,2',5'-Trichloroacetophenone**

Synonym:

CAS RN: Not available

Formula: $C_8H_5Cl_3O$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental program.

Environmental fate: Stable. Slow degradation by microorganisms.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 1, 27

Primary Name: **2,4',5'-Trichloroacetophenone**

Synonym:

CAS RN: Not available

Formula: $C_8H_5Cl_3O$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental program.

Environmental fate: Fate not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 27

Primary Name: **unsym-Trichlorobenzene**

Synonym: 1,2,4-Trichlorobenzene

CAS RN: 120821

Formula: $C_6H_3Cl_3$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: No information found.

Environmental fate: Stable (in aerated lagoon, including textile waste). Slow degradation by microorganisms. Solubility, 19 mg/L.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 1, 27, 31, 41, 128

Primary Name: 1,1,1-Trichloroethane

Synonym: alpha-Trichloroethane; Solvent 111; Chloroethene; Methyl chloroform

CAS RN: 71556

Formula: $C_2H_3Cl_3$

Information sources: Army/Shell

History of use, production, disposal & quantities: CAR, Section 35 - Uncontaminated (80, p. 14).

Monitoring history: Included in environmental monitoring program.

Environmental fate: Solubility, 4,400 mg/L. Biodegradation - persistent. Stable. Open flames can generate phosgene and hydrogen chloride.

Toxicity: Toxicity score, 2 (RTECS). EPA carcinogenic classification, D (not classified).

Included on target list(s): Ground-Water and Soil

References: 30, 31, 33, 37, 44, 54, 57, 80, 128

Primary Name: 1,1,2-Trichloroethane

Synonym: beta-Trichloroethane; Vinyl trichloride; Ethane trichloride

CAS RN: 79005

Formula: $C_2H_3Cl_3$

Information sources: Army/Lessee

History of use, production, disposal & quantities: HCIC Report: Literature Reviews on 54 RMA On-Post Contaminants (30).

Monitoring history: Included in environmental monitoring program.

Environmental fate: Liquid. Solubility between 4,000 to 5,000 mg/L (estimated). Microbiological degradation. Highly persistent. Log octanol/water partition coefficient 2.07.

Toxicity: Toxicity score, 2 (RTECS). EPA carcinogenic classification, C (possible human carcinogen).

Included on target list(s): Ground-Water and Soil

References: 30, 31, 33, 37, 54, 55, 128

Primary Name: **Trichloroethylene**

Synonym: Trichloroethene; TCE; ethylene trichloride

CAS RN: 79016

Formula: C_2HCl_3

Information sources: Army/Shell

History of use, production, disposal & quantities: CAR , Site 36-17 (66, p. 20); CAR, Section 35 - Uncontaminated (80, p. 14).

Monitoring history: Detected in environmental samples. Tentatively identified in surface drainage near RMA.

Environmental fate: Solubility, 1,100 mg/L. Vapor pressure, 60 mm at 20° C. Evidence of bioaccumulation. A common air contaminant. Stable in environment. Log octanol/water partition coefficient 2.07.

Toxicity: Toxicity score, 2 (RTECS). EPA carcinogenic classification, B2 (probable human carcinogen).

Included on target list(s): Ground-Water and Soil

References: 10, 27, 31, 35, 52, 54, 55, 66, 80, 128

Primary Name: **Trichloropropene**

Synonym:

CAS RN: 2567148 (1,1,3-trichloro-1-propene)
96195 (1,2,3-trichloro-1-propene)
2233003 (3,3,3-trichloro-1-propene)
21400259 (1,1,2-trichloro-1-propene)
26556036 (1,3,3-trichloro-1-propene)

Formula: $C_3H_3Cl_3$

Information sources: Not assigned

History of use, production, disposal & quantities: No information located.

Monitoring history: Tentatively identified as nontarget analyte in RI soil program.

Environmental fate: Not documented.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 31, 128

Primary Name: **2,4,6-Trichlorotriazine**

Synonym: Cyanuric acid chloride; Cyanuric chloride

CAS RN: 108770

Formula: $C_3Cl_3N_3$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: No information found.

Environmental fate: Not stable in the environment. Reacts rapidly with water and moisture. May be hydroxylated. Slow degradation by microorganisms, $t_{1/2}$ greater than 5 years. Insoluble in H_2O.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 1, 27, 31, 51, 128

Primary Name: **Triethyl phosphate**

Synonym:

CAS RN: 78400

Formula: $C_6H_{15}O_4P$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Soluble in water with some decomposition.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 27, 31, 37, 128

Primary Name: **Triethyl phosphite**

Synonym: **Phosphorus acid, triethyl ester**

CAS RN: 122521

Formula: $C_6H_{15}O_3P$

Information sources: **Shell**

History of use, production, disposal & quantities: **Readily Available Data Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).**

Monitoring history: **Not included in environmental monitoring program.**

Environmental fate: **Hydrolyzes to triethyl phosphate. Rapid degradation by microorganisms.**

Toxicity: **Toxicity score, not rated.**

Included on target list(s): **No**

References: **1, 27**

Primary Name: **Trihydroxytriethylamine**

Synonym: Triethanolamine

CAS RN: 102716

Formula: $C_6H_{15}NO_3$

Information sources: Army

History of use, production, disposal & quantities: History of Pollution Sources and Hazards at RMA (10).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Vapor pressure, less than 0.01 mm at 20° C. Log octanol/water partition coefficient, -1.32/-1.75.

Toxicity: Toxicity score, 1 (RTECS).

Included on target list(s): No

References: 10, 31, 41, 128

Primary Name: **Trimethylbenzene**

Synonym: Methylxylene

CAS RN: 25551137 (mixed isomers)

Formula: C_9H_{12}

Information sources: Not assigned

History of use, production, disposal & quantities: No information located.

Monitoring history: Tentatively identified as nontarget analyte in RI soil program.

Environmental fate: Occurs in coal tar and petroleum crudes. Practically insoluble in water. Miscible with alcohol, benzene, and ether. Solubility, 57 mg/L at 20° C (1, 2, 4 isomer).

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 31, 37, 128

Primary Name: **Trimethylhydrazine**

Synonym:

CAS RN: 1741011

Formula: $C_3H_{10}N_2$

Information sources: **Army**

History of use, production, disposal & quantities: CAR, Site 1-7 (92, p. 14).

Monitoring history: **Not included in environmental monitoring program.**

Environmental fate: **Fate not documented.**

Toxicity: **Toxicity score, not rated.**

Included on target list(s): **No**

References: **43, 92**

Primary Name: 2,3,5-Trimethyl phenol

Synonym:

CAS RN: 697825

Formula: $C_9H_{12}O$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Degraded by microorganisms. Slightly soluble in water.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 1, 27

Primary Name: 3,4,5-Trimethyl phenol

Synonym:

CAS RN: 527548

Formula: $C_9H_{12}O$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Degraded by microorganisms. Slightly soluble in water.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 1, 27

Primary Name: **Trimethyl phosphate**

Synonym:

CAS RN: 512561

Formula: $C_3H_9O_4P$

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Not documented.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 1, 27, 31, 42, 128

Primary Name: **Trimethyl phosphite**

Synonym: Phosphorus acid, triethyl ester

CAS RN: 121459

Formula: $C_3H_9O_3P$

Information sources: Shell

History of use, production, disposal & quantities: CAR, Sites 1-13 and 2-18 (73, p. 15); CAR, Site 26-6 (78, p. 17).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Hydrolyzed to trimethyl phosphate. Rapidly degraded by microorganisms. Slightly soluble in water. Volatile. Not stable in environment.

Toxicity: Toxicity score, 2 (RTECS).

Included on target list(s): No

References: 1, 27, 29, 31, 42, 73, 78, 128

Primary Name: **Tris-2-chlorovinylarsine**

Synonym: t-(betachlorovinyl)arsine

CAS RN: Not available

Formula: Not available

Information sources: Army

History of use, production, disposal & quantities: HCIC Report: Literature Reviews on 54 RMA On-Post Contaminants (30).

Monitoring history: Not included in environmental monitoring program.

Environmental fate: Not documented.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 30, 50

Primary Name: **Urea**

Synonym: Carbamide

CAS RN: 57136

Formula: CH_4N_2O

Information sources: Shell

History of use, production, disposal & quantities: Readily Available Data on 169 Compounds Associated with Operations at Rocky Mountain and Pine Bluff Arsenals (27); Denver Plant Waste Disposal Survey (42).

Monitoring history: No information found.

Environmental fate: Quickly hydrolyzes to ammonia in soil. Highly water soluble. Nitrate is ultimate product.

Toxicity: Toxicity score, 1 (RTECS).

Included on target list(s): No

References: 27, 31, 42, 52, 128

Primary Name: Vinyl chloride

Synonym: Chloroethylene

CAS RN: 75014

Formula: C_2H_3Cl

Information sources: Shell

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 17).

Monitoring History: No information found.

Environmental fate: Gas at room temperature and pressure. Microbial decomposition product of chlorinated ethenes and ethanes. Vapor pressure, 2,660 mm at 25° C. Solubility, 1,100 mg/L at 25° C.

Toxicity: Toxicity score, 3 (RTECS).

Included on target list(s): No

References: 1, 27, 31, 41, 42, 78, 128

Primary Name: VX

Synonym: Methylphosphonothioic acid s-[2-[bis (1-methylethyl)amino]ethyl] 0-ethyl ester

CAS RN: 50782699

Formula: $C_{11}H_{26}NO_2PS$

Information sources: Army

History of use, production, disposal & quantities: CAR, Section 36 - Nonsource Area (67, p. 11); CAR, Site 36-2 (107, p. 14); CAR, Site 31-7 (120, p. 15); CAR, North Plants (127, p. 13).

Monitoring history: No information found.

Environmental fate: VX reported to be both directly disposed of on ground and treated. Soil decomposition rate dependent on temperature, moisture, and pH. Anticholinesterase compounds - daughter products. Not stable in environment.

Toxicity: Toxicity score, 4 (RTECS).

Included on target list(s): No

References: 25, 52, 67, 107, 120, 127, 128

Primary Name: **Wheat rust, TX**

Synonym:

CAS RN: Not available

Formula: Not applicable. Not a chemical. It is a plant pathogen identified as uredispores of Puccinia Graminis var. tritici.

Information sources: Army

History of use, production, disposal & quantities: CAR, Section 20 - Nonsource Area (98, p. 9).

Monitoring history: No information found.

Environmental fate: Wheat was grown as host for wheat rust fungus. Wheat was harvested and fungal spores separated for inoculum. Nonviable spores were buried or incinerated and the ash buried in trenches near the north boundary. There is little reason to expect that any buried spores are still viable, since most spores lose viability within 6 months under conditions found in the burial trenches.

Toxicity: Toxicity score, not rated.

Included on target list(s): No

References: 2, 10, 18, 98

Primary Name: **Xylene**

Synonym: 1,3; 1,2; 1,4-Dimethylbenzene(m,o,p)

CAS RN: 1330207

Formula: C_8H_{10}, three isomers (m,o,p)

Information sources: Shell

History of use, production, disposal & quantities: CAR, Site 36-17 (66, p. 67); CAR, Site 26-6 (78, p. 17); CAR, Site 2-1 (82, p. 11); CAR, Site 32-6 (122, p. 15).

Monitoring history: Detected in environmental samples.

Environmental fate: Semivolatile. Aqueous solubility 180 mg/L. Degraded by microorganisms. Biodegradation - somewhat persistent. Log octanol/water partition coefficient 3.15 (para), 3.20 (meta), 2.77 (ortho). Solubility, 175 mg/L at 20° C (ortho), 198 mg/L at 25° C (para).

Toxicity: Toxicity score, 2 (RTECS). EPA carcinogenic classification, D (not classified).

Included on target list(s): Ground-Water and Soil

References: 1, 27, 29, 30, 31, 35, 42, 54, 56, 66, 78, 82, 122, 128

Primary Name: Zinc

Synonym:

CAS RN: 7440666

Formula: Zn

Information sources: Not assigned

History of use, production, disposal & quantities: CAR, Section 20 (98, p. 8).

Monitoring history: Included in both soil and ground-water monitoring programs.

Environmental fate: Forms salts with acids. Essential to plant growth. Recognized as one of the micronutrient elements. Stable in dry air.

Toxicity: Toxicity score, not rated.

Included on target list(s): Ground-Water and Soil

References: 45, 31, 48, 98

Primary Name: **Zinc oxide**

Synonym:

CAS RN: 1314132

Formula: ZnO

Information sources: Army

History of use, production, disposal & quantities: CAR, Site 26-6 (78, p. 17).

Monitoring history: Localized zinc contamination in northwest area of Basin A. Zinc noted in southeast corner of Basin F. Zinc oxide analysis performed with zinc as analyte.

Environmental fate: Occurs naturally in soil and water. Practically insoluble in water.

Toxicity: Toxicity score, not rated

Included on target list(s): No.

References: 10, 31, 37, 78

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96. Environmental Science and Engineering, Incorporated. December 1987. Draft Final Phase I, Contamination Assessment Report, Section 19-Nonsource Area, Version, 3.1, p. 8, Task Number 14.

97. Environmental Science and Engineering, Incorporated. May 1988. Final Phase I, Contamination Assessment Report, Site 20-1: Burn, Incendiaries, Version 3.1, p. 8, Task Number 14.

98. Environmental Science and Engineering, Incorporated. May 1988. Final Phase I, Contamination Assessment Report, Section 20-Nonsource Area, Version 3.1, pp. 7, 8, 9, Task Number 14.

99. Environmental Science and Engineering, Incorporated. March 1988. Final Phase I, Contamination Assessment Report, Section 25-Nonsource Area, Version 3.2, p. 8, Task Number 14.

100. Environmental Science and Engineering, Incorporated. December 1987. Final Phase I, Contamination Assessment Report, Site 29-1: Burn Site, Incendiaries,, Version 3.1, p. 8, Task Number 14.

101. Environmental Science and Engineering, Incorporated. April 1988. Final Contamination Assessment Report, Site 29-4: Disposal Site, Explosives and Incendiaries, Version 3.2, p. 11, Task Number 14.

102. Environmental Science and Engineering, Incorporated. May 1988. Final Phase I, Contamination Assessment Report, Site 30-2: Burn Site, Incendiaries, Version 3.1, p. 8, Task Number 14.

103. Environmental Science and Engineering, Incorporated. May 1988. Final Phase I, Contamination Assessment Report, Site 30-3: Mustard Training Area, Version 3.1, p. 8, Task Number 14.

104. Environmental Science and Engineering, Incorporated. January 1988. Final Phase I, Contamination Assessment Report, Site 30-5: M-34 Demilitarization Operation Area, Version 3.3, p. 7, Task Number 14.

105. Environmental Science and Engineering, Incorporated. February 1988. Final Phase I, Contamination Assessment Report, Site 30-6: Liquid Disposal Trenches, Version 3.2, pp. 10, 12, Task Number 14.

106. Environmental Science and Engineering, Incorporated. April 1988. Final Phase I, Contamination Assessment Report, Section 30-UNC-Nonsource Area, Version 3.1, pp. 6, 7, Task Number 14.

107. Environmental Science and Engineering, Incorporated. February 1988. Contamination Assessment Report, Site 36-2: Incendiary Drop Site, Version 3.2, pp. 10, 14, 15, Task Number 14.

108. Environmental Science and Engineering, Incorporated. February 1988. Final Phase I, Contamination Assessment Report, Site 36-6: Probable Test Site and Trench, Version 3.2, p. 9, Task Number 14.

109. Environmental Science and Engineering, Incorporated. May 1988. Final Phase I, Contamination Assessment Report, Site 36-9: Incendiary or Munition Test Area, Version 3.2, pp. 7, 9, Task Number 14.

110. Environmental Science and Engineering, Incorporated. April 1988. Final Phase I, Contamination Assessment Report, Site 36-14: Mustard Plant Disposal Site, Version 3.1, pp. 8, 12, Task Number 14.

111. Environmental Science and Engineering, Incorporated. April 1988. Final Phase I, Contamination Assessment Report, Site 36-16: Incendiary Burial Site, Version 3.1, pp. 8, 9, Task Number 14.

112. Environmental Science and Engineering, Incorporated. February 1988. Final Phase I, Contamination Assessment Report, Site 36-19: Grading Scars, Version 3.2, pp. 9, 10, Task Number 14.

113. Ebasco Services Incorporated. February 1988. Final Phase I, Contamination Assessment Report, Section 3-Nonsource, Version 3.2, pp. 16, 17, 18, 19, Task Number 15.

114. Ebasco Services Incorporated. January 1988. Contamination Assessment Report, Section 5-Nonsource Area, Version 3.1, p. 15, Task Number 15.

115. Ebasco Services Incorporated. June 1988. Final Phase I, Contamination Assessment Report, Section 6-Nonsource Area, Version 3.1, pp. 19, 23, 27, 28, 31, Task Number 15.

116. Ebasco Services Incorporated. December 1987. Final Phase I, Contamination Assessment Report, Section 8-Nonsource Area, Version 3.3, p. 10, Task Number 15.

117. Ebasco Services Incorporated. December 1987. Final Phase I, Contamination Assessment Report, Section 9-Nonsource Area, Version 3.2, p. 10, Task Number 15.

118. Ebasco Services Incorporated. July 1987. Final Phase I, Contamination Assessment Report, Section 12-Uncontaminated Area, Version 3.2, p. 14, Task Number 15.

119. Ebasco Services Incorporated. June 1988. Final Phase I, Contamination Assessment Report, Site 31-4: Toxic Storage Yard, Version 3.1, pp. 12, 13, 14, 15, 17, 19, 22, 23, Task Number 15.

120. Ebasco Services Incorporated. May 1988. Final Phase I, Contamination Assessment Report, Site 31-7: Toxic Storage Yard Storage Sheds, Version 3.1, pp. 12, 13, 15, 18, 22, Task Number 15.

121. Ebasco Services Incorporated. March 1988. Draft Final Phase I, Contamination Assessment Report, Site 32-5: Burning Pits, Version 2.1, pp. 9, 10, 11, Task Number 15.

122. Ebasco Services Incorporated. June 1988. Final Phase I, Contamination Assessment Report, Site 32-6: Burning Pits, Version 3.1, pp. 10, 12, 13, 15, Task Number 15.

123. Ebasco Services Incorporated. January 1988. Draft Final Phase I, Contamination Assessment Report, Section 32-Nonsource Area, Version 2.2, p. 12, Task Number 15.

124. Ebasco Services Incorporated. April 1988. Final Phase I, Contamination Assessment Report, Section 33-Nonsource Area, Version 3.1, p. 12, Task Number 15.

125. Ebasco Services Incorporated. April 1988. Draft Final Phase I, Contamination Assessment Report, Army Spill Sites, Version 2.1, pp. 7, 8, 9, 10, 15, 16, 21, 22, 23, 24, 25, 26, 28, 29, 30, 32, 35, Task Number 24.

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Appendix A

Comparison of the 1986 and 1988 versions of the RMA Chemical Indices

APPENDIX A

A.1 Comparison of the 1986 and Draft Final (May 1988) RMA Chemical Indices

The May 1988 version of the RMA Chemical Index contained changes in format and content from the 1986 version. Since the intent of the Chemical Index is to serve as a reference document to the RMA remedial investigation (RI) and endangerment assessment (EA), it is necessary that as much RMA-specific information as possible be included.

Many of the entries included in the 1986 version contained limited information linking them to RMA activities, and little or no data regarding the chemicals' properties, environmental fate, or toxicity. A screening procedure was developed to remove entries having limited information and hence, limited usefulness to the RI and EA programs being carried out at the Arsenal.

Seven criteria were used for this screening process; they are as follows:

- The entry contains no RMA-specific information regarding quantity used, quantity disposed or the disposal method, time frame of association with RMA activities, relation to other compounds associated with RMA activities, or the detection of the compound in the RMA environment.

- The entry represents a physical material, not a chemical as the Index title indicates.
- The entry represents a trade name compound and/or formulation with no ingredient data available (i.e., composition of product is unknown and as a result no assessment regarding environmental impact is possible).
- The entry represents a salt, light end, or impurity of another (parent) entry; pertinent information from this entry is included in the parent compound entry.
- The entry contains ambiguous information with limited usefulness in the ARAR determination.
- The entry represents an additive, emulsifier, surfactant, or catalyst used in small quantities; no other information is usually available for these items.
- The entry represents a laboratory reagent.

A list of those entries that had been removed from the 1986 version and the basis for removal is presented in Table A-1. As a result of reducing the number of entries in the May 1988 version of the Index, the need for the chemical matrix became unnecessary. Removal of the matrix also has eliminated the problem of presenting information in an abstracted fashion which, of necessity, was incomplete.

The reporting format for each chemical entry has also been reorganized to facilitate the retrieval of data. Although some headings have been revised, no information needed to support the RI or EA has been deleted. Some information has, however, been moved to more appropriate headings. The changes to each of the 1986 headings, as compared

with the May 1988 and current Indices, are discussed in detail below.

Common Name or Abbreviation

This heading has been replaced by "Primary name," as the key to each entry. In the previous version of the Index, no standard nomenclature system was used. The May 1988 and current Indices reflect the results of nomenclature standardization as well as the change in headings. Chemicals listed by a name different from that used in the 1986 edition are listed in Table A-2.

Chemical Name

This heading has been replaced by "Synonym." The synonym heading now includes the 1986 Index entry main heading if it differs from the Primary Name used in this version.

Formula

There has been no change in this heading.

Assignment

This heading has been replaced by "Information sources." There has been no change to the content of the heading.

History of Use, Production, Disposal

This heading has been replaced by "History of use, production, disposal & quantities." The data contained under the 1986 heading "Reported Quantities" are now also presented under this heading.

Reported Quantities

The data presented under this heading have been combined with the data from the "History of Use, Production, & Disposal" heading of the 1986 version, and is included under the heading "History of use, production, disposal & quantities."

Environmental History and Fate

Data regarding the environmental monitoring history of a chemical have been noted and included under the new heading "Monitoring history." Environmental fate data are now listed under a heading entitled "Environmental fate."

Included on Priority Lists?

This heading has been replaced by "Included on target list(s)." All chemicals designated as target analytes for either the soil or ground-water investigations under the RI program are noted. These notations replace previous references to the "Hit List" and "Potential for Migration List."

Toxic Hazard Review

This heading has been replaced by the "Toxicity" heading. In the 1986 Index, the "Toxic Hazard Review" heading was available only for some compounds. The "Toxicity" heading has been included for all compounds.

References

There has been no change in this heading.

CAS RN

This is a new heading in the May 1988 and current versions of the Index and contains the Chemical Abstract Services Registry Number for each chemical.

A.2 Comparison of the May 1988 and August 1988 versions of the RMA Chemical Index.

The August 1988 version of the RMA Chemical Index contained changes in content from the May 1988 version. These changes are predominantly based on the comments received from the Organizations and the State regarding the May 1988 version.

A number of compounds were removed in the preparation of this version; their removal was generally related to the compounds' environmental fate (ie. their low persistence.) Table A-3 lists the compounds which have been removed. Two compounds were added to this version; they are chloroacetophenone and formaldehyde.

The content of each entry's information headings have remained the same except for the "History of use, production, disposal and quantities" and the "Toxicity" headings. The statements concerning the chemical's history at RMA (as given under "History of use, production, disposal and quantities") in the May 1988 version of the Index have been deleted. These historical summaries have been replaced by cross references to the CARs, the Army's or Shell's interrogatory answers, or original references. The "Toxicity" heading now contains only a toxicity score (the methodology for determining this score is given in the Introduction to the Index and if available, the USEPA

carcinogenic classification; all Sax ratings have been deleted.

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Explanatory Notes

1: No-site specific information available, i.e., no quantity, time frame of use, relation to other compounds, or detection in the RMA environment information.

2: Physical material.

3: Trade name compound and/or mixture with no compound-specific data.

4: Related salt, light end or reference to and data of another entry; information from this entry is included in parent or referenced compound entry.

5: Lab reagent.

6: Entry information is ambiguous.

7: Additive, emulsifier, surfactant, or catalyst used in small quantity.

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Accel plant growth regulator, SD8339	1
Acrolein diacetate	1
Adol 34	1,3
Aerosol OT - 100*	1,3
Agrimul emulsifier	1,3,7
Alizarin cyanone green dye	1,3
Allyl glycidyl ether	1
Allyl glycidyl ether/ vinylite	1
Aluminum	1
Aluminum oxide	1,3
Alvania EP Grease-2	1,3
Ammonium hydroxide	1
Anglamol Base A	1,3
Anti-icer	1,3
Armeen DMCD	1,3
Arsenic compounds	1,4
Asbestos (Amianthus)	2
Atlox 1045A, 3335, 3403F, 3404F, 8916	1,3,7
Attaclay, Fuller's earth	2,3
Attapulgus clay, Fuller's earth	1,2,3
Azodrin light ends	4
Azodrin-related salts	4

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Azomethane	1
Barium chloride	1
Base Oil 40	1,3
Bentonite PPM20	1,2,3
Benzaldehyde	1
Benzal chloride	1
Benzanthrone	1
n^6-Benzyladenine, SD4901	1,3
Beryllium	1
Bicarbonate	1
Bis-2-chloroethyl mercapto (ethyl) ether	1
Bis(diisopropylaminoethyl) disulfide	1
Bis(diisopropylaminoethyl) sulfide	1
1,1-Bismethylthioethane	1
Bismuth	1
Borax	1,2
Boraxo Powdered Hand Soap	1,2
Boron	1
Bromine chloride	1
m-Bromobenzaldehyde	1
Bromoform	1
t-Butyl hydroperoxide	1
Butyl phthalylbutylglycolate	1

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
By-product fuel	1,3
Calcium bicarbonate	1
Calcium sulfate	1
Calcium sulfite	1
Captax	1,3
Carbamate	1,3
Carbon, activated	1,2
Carbon dioxide	1
Carbon disulfide	1
Carbon monoxide	1
Chlorinator products	4
Chloroacetophenone	1
2-Chloro-N,N-dimethyl-acetoacetamide	1
1-Chloroethylbenzene	1
Chloromethyl phosphonic dichloride	1
Chloronitrobenzene	1
4-Chloro-3-nitrophenyl methyl sulfone	1
2-(p-Chlorophenyl)-3-methylbutyric acid	1
Chlorothiophenol	1
2-Chlorovinyldimethyl phosphate	1
Cobalt	1
Copper sulfide	1

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Cottonseed oil	1,2
Curing Agents A & C1	1,3
Cycloheptatriene	1
Cyclohexane	1
Cyclohexanone glycol	1
Cyprina grease 3	1,3
Darina grease 2, lubricating grease	1,3
2,4-D	1
Delta-keto	1,3
Diacetone alcohol	1
Diadduct	1,3
Diazinon	1,3
cis-Dibromodichloropropene	1
Dibromomethane	1
Dibutyl phthalate	1
Dichloroacetic acid	1
m-Dichlorobenzene	1
o-Dichlorobenzene	1
Dichloroisophorone	1,5
5,7-Dichloro-2-methyl benzofuran	1
Dicyclohexylphthalate	1
Diethylenetriamine	1
Di-2-ethylhexylamine	1

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Di-2-ethylhexylphthalate	1
Dihydropyran	1
Diisobutyl phthalate	1
N,N'-Diisopropylcarbodiimide	1
N,N-Dimethylformamide	1,5
O,O-Dimethylisopropenyl phosphate (SD3886)	1
O,O-Dimethyl methylthiophosphonate	1
Dimethyl phosphonate	1
Dimethyl phosphoric acid	1
O,O-Dimethyl phosphonic acid	1
Dimethyl phosphorodithioic acid	1
O,O-Dimethyl thionophosphonate	1
m-Dinitrobenzene	1
2,6-Dinitro-4-methyl sulfonylaniline	1
Dioctyl adipate	1
O,O-Dioctyl-o-(2,2-dichlorovinyl) phosphate	1
Dioctyl phthalate	1
Dipotassium acid phosphate	1
Dipropylamine hydrochloride	1
Dipterex	1,3
DMP-30	1,3

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Dodecylamine	1
Dowtherm	1,2
Duponal	1,3
Dursban	1,3
Emulphogene	1,3,7
Emulphogene BC-720	1,3,7
Emulphor surfactants	1,3
Emulsipher	1,3,7
Enjay stock	1
Epichlorohydrin	1
Epon 828	1,3
Epon 834	1,3
Epon 1001	1,3
Espisol	1,3
Ethyl alcohol	1
Ethylene bistolylsulfide	1
Ethylene glycol	1
Ethylene glycol monoethyl ether, Cellosolve	1,3
Ethylether	1
2-Ethylhexanoic acid	1
Ethyl parathion related salts	4
Farnesol	1,3
Fenthion	1,3

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Ferric/Ferrous bromide	1
Ferric/Ferrous chloride	1
Fibraflow 4C and Hydro Supercel filter aids	2,3
Formaldehyde	1
Formaldehyde hydrazine	1
Fuel oil (#2)	1
GAFAC Surfactants	3,7
Gasoline	1
Gold	1
Heavy amine	1
Hexachlorobenzene	1
Hexachlorobutadiene	1
Hexachloroethane	1
Hexachlorotoluene	1
Hexamethylenetetramine	1
Hydrogen	1
Hydrogen bromide	1
Hydrogen chloride	1
Hydroxybicyclo(2,2,1) hepta-2,5-diene	1
7-Hydroxynorbornadiene	1
Igepal CA-630	3,7
Igepal CA-897	1,3,7
Iodine	1
Iron	1

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Isooctane	1
Karl Fischer Reagent	1,5
Kelzan	1,3
Kerosene	1
Lanthanum	1
Lauric acid	1
Lead azide	1
Lime (2 entries)	4
Lime sludge, milk/lime	4
Lindane	1
Liquified petroleum gas	1,6
Lithium	1
LTS lotion soap	1,3,2
LVI 100 neutral oil	1,3
Magnesium salts	4
Marasperse	1,7
Marasperse B-22	1,7
2-Mercaptobenzothiazole	1
Methane	1
1,4-Methanonaphthalene-5,8-dione dimethyl aniline	1
Methoxychlor	1
N-Methylacetamide	1
O-Methylbenzylchloride	1

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Methylbenzyl-2,2-dichloro-acetoacetate	1
N-Methyl-2-chloroaceto-acetamide	1
Methyl cyclopentadiene	1
N-Methyl-2,2-dichloroacetamide	1
Methyl dichloroacetoacetate	1
Methyl dioctyl phosphite	1
Methylene Blue Active Substance	1
4,4-Methylenedianiline	1
Methylene glycol	1
Methyl ethyl ketone	1
S-Methyl methylthio-carbonic acid	1
O-Methyl methylthio-phosphate	1
O-Methyl methylthio-phosphonate	1
O-Methyl methylthio-phosphonic acid	1
O-Methyl-O-octyl-O-2,2-dichlorovinylphosphate	1
Methyl parathion related salts	4
Methylphosphonic difluoride	1
Methyl polysulfide	1
alpha-Methylundecanal	1
Molecular sieves	1

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Molybdenum	1
Molybdenum trioxide	1
Monochloromethyl phosphonic acid	1
Montan wax	1,2
Naphthalene	1
Nickel	1
Niobium	1
p-Nitroanisole	1
Nitrogen	1
p-Nitrosodium phenolate	1
Nonane	1
Octane	1
n-Octyl alcohol	1
Omala oil 680	1,3
Oxitol	1,3
Oxygen	1
Pate's Sulfurized Pale Oil	1,3
Peladow	1,3
Pentane	1
Pentoxone	1
Petroleum Oil Extracts	1
m-Phenoxybenzadehyde	1
m-Phenylenediamine	1
Phenylglycydyl ether	1

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Phosphate	1
Phosphorus pentasulfide	1
Phosphorus trichloride	1
Picrylchloride	1
Planavin-related salts	1,4
Pluronic L-61	1
Polychlorinated biphenyls	1
Polyvinyl acetate	1
Polyvinyl chloride	1,2
Portland cement	1,2
Potassium chloride	1
Potassium iodine	1
Potassium thiocyanate	1
Prilled urea	1
Primene JM-T	1,3
Primene 81-R	1,3
Propane	1
Purafil media	1,2,3
Purple K	1,3
Pyridine	1
Retrol clay	2
Rosin, wood	2
Rotella oil	2,3
Rotenone	1,3

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Salicylic acid	1,5
Santocel	2,3
Santomerse no.1	1,3
Scandium	1
SD 6581	1,3
SD 7438	1,3
SD 9098	1,3
SD 15042	1,3
Selenium	1
Shell Anti-freeze (59-14-6)	1,3
Shellchlor insecticide	1,3
Shell cyclo-sol 53	1,3
Shell De-icer	1,3
Shell Flex 210 oil	1,2,3
Shell Poultry Larvacide	1,3
Shell Sodium Sulfonates	1
Shellsol 360	1,3
Silica	1,2
Silver	1
Silver nitrate	1,5
2,4,5-T Silvex	1
SMA 1440 H	1,3
Sodium acetate	1,4
Sodium bisulfate	1

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Sodium bromide	1
Sodium chromate	1,4
Sodium cyanate	1
Sodium dichromate	1
Sodium hypobromite	1
Sodium isopropoxy-methylphosphine	1
Sodium mercaptide	1
Sodium mercaptobenzo-thiazole	1
Sodium metasilicate	1
Sodium nitrate	1,4
Sodium orthophosphate	1
Sodium sulfide	1,4
Sodium tripolyphosphate	1,7
Sodium tungstate	1,5
Sponto 232	1,3
Sponto 234	1,3
Sponto 246	1,3
Starch	1,2
Strontium	1
Sulfamic acid	1
Sunisco 4GS	1,3
TAC	1
TCMPA	1,3
T-Det 0407	1,3

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Tellus oil 68, 69, 100	1,3
Telodrin	1,3
Tenneco 500-100	1,3
Tetrachlorobenzene	1
Tetrachloro-p-benzo-quinone	1
Tetrachlorocyclopentane	1
Tetrahydrofuran	1
Tetramethylpyrophosphate	1
Tetramethylthionopyrophosphate	1
Tetramethyl urea	1
Titanium	1
Titanox	1,3
T-Mulz-N121	1,3,7
Toxaphene	1
Trem Y-24	1,3,7
Tret-o-lite	1,3,7
Trex 40	1,3,7
Triallylamine	1
Trichloroethylene epoxide	1
Trichloromethane phosphonic acid	1
Triethylamine	1
Triethylene triamine	1
Trimethylammonium chloride	1

Table A-1 April 1986 RMA Chemical Index Entries That Are Removed from the May 1988 Version of the Index

Entry	Reason
Trimethyl arsine	1
Tripiperazine	1
Trisodium phosphate	1
Trisphenol (BPX)	1
Tritium	1
Triton	1,3,7
Triton X-100	1,3
TS-28R	1,3
Tungsten	1
Uranine C	1,3
Uranium	1
Vacuum tower bottoms	1,6
Vanadium	1
Vaporizer bottoms	1,6
Vazo	1,3
Versene	1,3
Versene, FeIII-specific	1,3,7
Vinylite AYAF	1,3
Wax	1,2,6
WD-40 spray penetrant	1,3
Yttrium	1
Zirconium	1

Table A-2. Chemical Entries of the May 1988 Index Which Were Listed by an Alternative Name in the 1986 Index.

1988 Nomenclature	1986 Nomenclature
Acetaldehyde oxime[1]	Acetaldoxime
3-Oxo-butanoic acid	Acetoacetic acid
2-Methyllactonitrile[1]	Acetone cyanohydrin
2-Methylalanine	a-Amino-iso-butyric acid
Nitrous acid, ammonium salt	Ammonium nitrite
Antimony (III) chloride	Antimony trichloride
Arsenic chloride	Arsenic trichloride
Bicyclo (2.2.1) hepta-2,5-diene	2,5-Norbornadiene
Bicyclo (2.2.1) heptadiene	Norbornadiene
Bicyclopentadiene[2]	Dicyclopentadiene
Bromic acid, potassium salt	Potassium bromide
Hypochlorous acid, calcium salt	Calcium hypochlorite
Phosgene	Carbonyl chloride
Chloral hydrate	Chloral
4,5,6,7,8,8-Hexachloro-3a, 4,7,7a-tetrahydro-4,7-methene-1,H-indene	Chlordene
4-Chlorobenzenethiol	p-Chlorobenzenethiol
3-Bromo-1-chloro-1-propene	Chlorobromopropene
Crotoxyphos	Ciodrin insecticide
2,4,6-Trichlorotriazine	Cyanuric chloride
2-Cyclohexen-1-one	Isophorone
1,2-Dibromo-2,2-dichloroethyl[1] dimethyl phosphate	Dibrom
1,1-Dibromoethane	Dibromoethane
cis-Dichloroethylene	1,2-Dichloroethylene

Table A-2. Chemical Entries of the May 1988 Index Which Were Listed by an Alternative Name in the 1986 Index.

1988 Nomenclature	1986 Nomenclature
Dicrotophos	Bidrin
Phosphoric acid, diethyl ester	Diethylphosphate
p-Nitrophenyl diethylphosphate	Diethyl-4-nitrophenol phosphate
2,4-Dihydroxy-2-methyl pentene	Hexylene glycol
2-[Bis(1-methylethyl)amino] - ethanethiol	Diisopropylaminoethanethiol
N,N-Diisopropylethanolamine	Diisopropylaminoethanol
Hydroxydimethylarsine oxide[1]	Dimethylarsinic acid (also dimethyl arsenic acid)
DDVP	Vapona
1,1-Dimethylhydrazine	Unsymmetrical dimethyl hydrazine
Dimethylnitrosamine	N-Nitrosodimethylamine
1,4-Dithiane	Dithiane
2,6-Di-tert-butyl-p-cresol	Ionol
Ethanamine	Ethylamine
Sulfuric acid, fuming	Oleum
Sarin	GB
1,2,3,4,7,7-Hexachlorobicyclo (2.2.1) hepta-2,5-diene	Hexachloronorbornadiene
Hexone	Methylisobutyl ketone
Hydrocyanic acid[1]	Hydrogen cyanide
Fenvalerate	Pydrin
Isobutylmethacrylate	IM gel
Iron (III) oxide	Iron oxide

Table A-2. Chemical Entries of the May 1988 Index Which Were Listed by an Alternative Name in the 1986 Index.

1988 Nomenclature	1986 Nomenclature
Mineral Oil	Kaydol
Magnesium	Magnesium metal
Mercaptodiacetic acid	2,2'-thiodialycolic acid
Mercuric chloride	Mercury chloride
Methane dichloride	Methylene chloride
Methanethiol	Methylmercaptan
Methyl acetylacetate	Methyl acetoacetate
a-Phenylethyl alcohol	a-Methylbenzyl alcohol
Monochloromethane[1]	Methylchloride
N-Methylacetoacetamide	N-Methyl-3-oxo-butanamide
2-Chloro-3-oxo-butanoic acid, methyl ester	Methyl-2-chloroacetoacetate
Methanethiol, sodium salt	Methylmercepten, sodium salt
Petroleum spirits	Mineral spirits
4-Nitrophenol	p-Nitrophenol
Nitrogen oxide	Nitrous oxide
Methomyl	Nudrin Insecticide
1,4-Oxathiane	Thioxane
Peroxyacetic acid	Peracetic acid
Peroxybenzoic acid	Perbenzoic acid
Methylphosphonic acid, disodium salt	Sodium methyl phosphonate
4-Nitrophenol, sodium salt	Sodium p-nitrophenolete
Sulfur chloride	Sulfur monochloride
Chlorfenvinphos	Supona

Table A-2. Chemical Entries of the May 1988 Index Which Were Listed by an Alternative Name in the 1986 Index.

1988 Nomenclature	1986 Nomenclature
2,2-Dichloro-1-(2,4-dichlorophenyl)-ethanone	2,2,2',4'-tetrachloro acetophenone
unsym-Trichlorobenzene	1,2,4-Trichlorobenzene
Trihydroxytriethylamine	triethanolamine
Phosphoric acid, 2,2-dichloro-ethenylmethyloctyl ester	Vincophos

[1]Compound was removed from the August 1988 version of the Chemical Index

[2]Compound listed as Dicyclopentadiene in the August 1988 version of the Chemical Index

Table A-3. May 1988 RMA Chemical Index Entries That Are Removed From or Added to the August 1988 Version of the Index

Compound	Description
Acetaldehyde	Removed
Acetaldehyde oxime	Removed
Acetamide	Removed
Acetic acid	Removed
Acetophenone	Removed
Acetylene	Removed
Aldrite 4EC	Removed
Allyl chloride	Removed
Aluminum chloride	Removed
Bicyclopentadiene	name changed; listed as Dicyclopentadiene
Calcium oxide	Removed
Chlorine	Removed
Chloroacetylchloride	Removed
Chloroacetophenone	Added
2-Chlorovinylarsonous acid	Removed
Curing agent C-III	Removed
Curing agent D	Removed
Curing agent U	Removed
Curing agent Z	Removed
Cutting oil additive C-400	Removed
Cutting oil additive C-403	Removed
1,2-Dibromo-2,2-dichloroethyl dimethyl phosphate	Removed
Dichloroacetyl chloride	Removed
Diketene	Removed
Dimethylamine	Removed
Ethylene	Removed
Formaldehyde	Added
Hydrocyanic acid	Removed
Hydrogen peroxide	Removed
Hydroxydimethylarsine oxide	Removed

Table A-3. May 1988 RMA Chemical Index Entries That Are Removed From or Added to the August 1988 Version of the Index

Compound	Description
Isopropyl alcohol	Removed
Ketone	Removed
Methanol	Removed
Methylamine	Removed
Methylethyl ketone	Added
Methyl isocyanate	Removed
2-Methylactonitrile	Removed
Monochloromethane	Removed
Nitrogen oxide	Removed
Paint Thinner	Removed
Paraffin	Removed
Parathion	Removed
alpha-Phenethyl alcohol	primary name corrected; now listed as alpha-phenylethyl-alcohol
Tetrahydrofuran	Removed

Shell Oil Company

One Shell Plaza
P O Box 4320
Houston, Texas 77210

July 22, 1986

24 JUL RECD

USATHAMA
Office of the Program Manager
Rocky Mountain Arsenal Contamination Cleanup
ATTN: AMXRM-EE: Chief: Mr. Donald L. Campbell
Bldg E4585, Trailer
Aberdeen Proving Ground, MD 21010-5401

Dear Mr. Campbell:

Shell has reviewed the Army's report "Rocky Mountain Arsenal, Chemical Index, Final Draft Report", prepared by Geraghty and Miller, Inc. dated April 1986. It is apparent that extensive effort has been expended in preparation of the report, and a correlative review effort has been invested by Shell.

Shell's comments are presented in the attachment to this letter. After you have had the chance to review our comments, we are prepared to discuss them in detail, if you desire.

As we advised when you provided this document for our review and comment, Shell is preparing a similar document. The Shell version of chemical ranking of the chemicals will be provided when its internal review is completed. We will solicit Army comments on our proposed listing of target compounds.

Very truly yours,

C. K. Hahn

C. K. Hahn
Manager
Denver Site Project

cc: Mr. Thomas Bick
Land & Natural Resources Division
U.S. Department of Justice
P.O. Box 23896
Benjamin Franklin Station
Washington, D.C. 20026

Major Robert J. Boonstoppel
Headquarters - Department of the Army
ATTN: DAJA-LTS
Washington, DC 20310-2210

BTWW8620201/HM

cc: Ms. Patricia Bohm
Office of Attorney General
CERCLA Litigation Section
1560 Broadway, Suite 250
Denver, CO 80202

Mr. Robert L. Duprey
Director, Air & Waste Management Division
U.S. Environmental Protection Agency
Region VIII
One Denver Place
999 18th Street, Suite 1300
Denver, CO 80202-2413

ATTACHMENT I

COMMENTS ON "ROCKY MOUNTAIN ARSENAL, CHEMICAL INDEX"

1. The first paragraph of the Index contains a statement of intent to provide the user with pertinent information regarding the "chemical's production, use, disposal, and environmental impact to the extent that the information is available". It would be appropriate to add "toxicity" to the list since toxicological information is included in the Index and Matrix.

2. We suggest that the introduction acknowledge all facets of remediation, not just chemical decontamination. Chemical decontamination is but one of the many facets of remediation on the RMA. For example, consider UXO's, removal of large quantities of concrete, demolition of buildings and processing facilities, etc.

3. It is unclear whether the "Hit List" and the "Migration List" are minimum lists of intended analytes to which other chemical names could be added for specific areas of the site, or whether they are the ultimate lists for which the analyses for any given sample will be selected.

4. The second paragraph of the introduction indicates that chemicals were added when research showed they were associated with RMA operations. What records were included in the research? Were any documents researched which indicate the likely breakdown or degradation products?

5. It appears that many compounds which were used on the RMA are absent from the Index. For example:

   Bromine
   Lacquer thinners
   Symmetrical 1,2-dimethyl hydrazine

   A comparison to the total list of chemicals indicated to be present or handled on the RMA might possibly expand the list.

6. The Army list notes that some of the compounds listed are possible degradation products of materials handled by Shell on the RMA. However, the Army has not chosen to list the potential degradation products of the materials they handled on the RMA. Shell had previously given the Army a list of potential surety degradation products along with an offer to provide analytical reference material.

7. The Army was associated with at least the following compounds (and there may be others) which are not listed in the index:

Aluminum trichloride
Arsenic pentoxide
Button incendiary charge
Calcium flouride
Calcium methylphosphate
Calcium orthoarsenate
Chlorovinylarsenious oxide
Daxad
Di-Di mixture
Diethyldodecane
1,2-dimethylhydrazine
Disodium methylphosphonate
n-Dodecane
Ethylene oxide
Freon
Hydrochloric acid
Isopropyl ester
Isopropyl methylphosphonochloridate
Lacquer thinner
M-2 thickner
Magnesium carbonate
Magnesium oxide
Methyl hydrazine
Napalm
2-Octylphthalate
Phosphate detergent
Polyvinyl alcohol
Potassium chlorate
Pyrotechnic incendiary mixture
Separan flocculant
Sodium arsenite
Sodium flouracetate
Sodium isopropylmethyl phosphonate
Sodium phosphate
Ureabor
Miscellaneous greases and lubrication compounds which must have been used.

8. Contrary to statements in the Introduction, there appears to be chemicals listed in the "hit list" or "migration list" which are not currently included in the Army's sampling program. Please clarify why this is the case. The following are some of the chemicals in this category:

   Atrazine
   Azodrin
   Bromide
   1,1-Dichloroethane
   1,2-Dichloroethane
   1,2-Dichloroethylene
   Dimethyl disulfide
   Methylene chloride
   Supona
   Thiodiglycol
   1,1,1-Trichloroethane
   1,1,2-Trichloroethane

9. What are the "core lists" referred to in the Matrix Key, first paragraph under "Toxicity Rating"? What are core lists used for?

10. In the detail sheets, one of the headings is "Included on priority lists". What is a "priority list"? What is a priority list used for? What is the basis of a priority list?

11. Introduction, page 3, first bullet; the fact that a compound was produced in large quantities at RMA labels it as a suspected contaminant and as candidate for either the "hit list" or the "migration list". What logic was used to determine that high volume production items are necessarily on either list? Isn't it more appropriate to focus on the volume disposed of on the RMA since a good portion, if not almost all of some of the compounds produced were sold or otherwise utilized?

12. Introduction, page 3, first sentence states: "Selection of a compound to the lists may include some or all of the following criteria:". What logic was used to decide which criteria to use, and when to use them? What criteria were used to exclude a compound from one list that was already on the other list?

13. Other selection criteria for including compounds on the "priority" lists were stated in the detail sheets. Some of the criteria listed in the detail sheets are: natural

constituent, tracer, spilled, widespread contaminant, mobile, and used. Why were these reasons not acknowledged in the introduction? Were any other selection criteria used but not mentioned in the Index? Were these criteria applied equally to all compounds, or did the source of the compounds have an impact on their selection?

14. Cyanide is not included on either the "hit list" or the "migration list" even though the Index states it has been "detected in environmental samples", and "included in groundwater and Basin F fluid analysis". In contrast cadmium, chromium, DDE, methylene chloride, 1,1-dichloroethane, 1,2-dichloroethane, DIMP, and lead to name a few have been placed on one or both of the lists for the same reason that cyanide has been excluded. Please explain this.

15. We find many examples of confusing, conflicting and subjective logic in selecting compounds for the "hit list" and "potential for migration" lists. For example:

    a. Sodium and magnesium salts are short listed for the same reason that aluminum compounds are not.

    b. Acetylene tetrachloride is not short listed because it is "not stable in the environment". However, Vapona, Azodrin, Dimethyl disulfide, which are described as, and are, short lived are included on one or both lists.

    c. Antimony is not short listed because it has not been detected in environmental monitoring programs. Is the reader to assume all the compounds on the short list have been found in the environment above detectable limits?

    d. Octachlorocyclopentene, OCCP, is not short listed because "slight aqueous solubility suggests the compound is relatively immobile". Are no immobile or insoluble compounds short listed?

16. Please clarify the logic for not selecting a compound to one of the two short lists. This explanation of selection logic needs to be part of the document proper.

17. The upper case letter "M" is used in the "reported quantities" field. Does it stand for 1,000 or 1,000,000?

18. In the matrix, many terms represent a general class of compounds which can not be given discreet characteristics, i.e. Atlox, GAFAC surfactants, Marasperse, Delta-keto, and Phenolics.

19. In some instances both the compounds and synonyms are listed.

20. In many cases the ion of a metal is meant where the metal is stated. We need to come to agreement on a common technique to handle this situation.

21. "Karl Fischer Reagent" is a laboratory chemical. Does the Army intend to list all laboratory chemicals? Shouldn't this be excluded?

22. Asbestos, a filter aid and insulator, is not included on the "hit list". According to the data sheet, asbestos (listed under "amianthus"), is "not considered to be a contaminant". In remediation of the RMA, however, asbestos might require inclusion in the remedial action plan.

23. Oleum is sulfur trioxide dissolved in concentrated sulfuric acid. None of these are likely to be "in RMA environment" as indicated in the matrix.

24. Toxicity citations are based on secondary or tertiary sources and in many instances the work effort is incomplete. Sax or the Merck Index shouldn't be depended upon as the source of toxicity information. At the very least the widely available Registry of Toxic Effects of Chemical Substances, which can be obtained in hard copy, microfiche, or on-line with a computer modem, is the first choice. Further, in the Matrix summary which is designed to help readers (and by implication allow them to ignore the rest of the document) the toxicity column is filled in on a hit-and-miss basis which often seems prejudicial. We find it more than interesting that many of the Army's surety compounds don't seem to have any available toxicity information.

25. The "Assignment" category in the report is potentially very misleading. What meaning does the label "Assignment" have? An unstated implication is that the organization to which the compound is "Assigned" also has the "blame" assigned. It would be more appropriate to substitute a more meaningful term such as "purchased by" or "produced by".

26. When the Arsenic heading lists the presence of arsenic in Shell fuel oil on the same basis as the Army's Lewisite, the bias is overwhelming! Another example either of inaccurate work or of bias in this report is the listing of Portland Cement as a Shell only item.

27. Some of the chemicals listed in the Index are assigned to the Army. However, the same chemicals assigned to the Army were not included in earlier interrogatory responses. Why?

28. On what basis has Benzothiazole been assigned to Shell? We can find no basis for this; hence, it may be an Army compound.

29. Chlorobenzene should be assigned to the Army.

30. Dimethyl methyl phosphonate (DMMP) is also a by-product from various Shell manufacturing processes.

31. The Army may have been associated with the following compounds which the Index doesn't attribute to the Army:

Atrazine (see chemical pesticide inventory)
Asbestos
Bis-(carboxymethyl) sulfone/sulfoxide
Bis-2-chloroethylmercapto (ethyl) ether
Bis (diisopropylaminoethyl) disulfide
Bis (diisopropylaminoethyl) sulfide
Borax/Boraxo powdered handsoap
Carbon, activated
Chloroacetic acid
Dieldrin (grasshopper control/chemical pesticide inventory)
2-Diisopropylaminoethyl sulfonate
Dimethyl arsinic acid
Dimethyl mercury salts (mercury salts and methyl mercury)
Dursban (chemical pesticide inventory)
Endrin (chemical pesticide inventory)
Fluoroacetic acid
Methyl arsonic acid
Methyl mercury salts
Methyl phosphonic acid, isopropyl ester
Portland cement
Rotenone
2,4,5 T-Silvex
Tetrachloroethylene
2-2'-Thiodiglycolic acid

32. We have no records that Shell was associated with the following chemicals (suggest the references be checked):

    Arsenic
    Arsenic compounds
    Diazinon
    Trimethyl arsine

33. Shell may have been associated with the following (suggest additional research to confirm):

    4 Chloro-3-nitrophenyl methyl sulfone Dowtherm A
    Epon 828
    Epon 1001
    Ethylene glycol
    Fuel oil #6
    Gasoline
    Hydroxybicyclo (2.2.1) hepta-2, 5-diene
    7-Hydorxynorbornadiene
    O-methyl methyl thiophosphonate
    O-methyl methyl thiophosphonic acid
    Nitric acid/sulfuric acid (mixed)
    Paint thinner
    Sodium bicarbonate
    Sodium hypochlorite
    Titanium

34. When a compound is described as "persistent", what special attribute describes the threshold which must be exceeded? Under what conditions was the persistence determined?

35. The persistence data provided in the detail section is questionable. For example, the Index states the half life of napthalene is less than one month and of low persistence. However, a CERLA reference (40 CFR Part 300, 7/1/85, Appendix A) states this compound is "somewhat persistent".

36. When a compound is indicated as being toxic, what special attribute describes the threshold which must be exceeded? Under what conditions was the toxicity determined?

37. On page 4 of the Introduction, the ranges selected for "volume" of production and disposal appear arbitrary. What is the basis for the various cut-points? Are these annual figures or total figures? What data base was

used to determine production and waste disposal volumes of Army compounds? Why didn't the Army provide this information in their interrogatory answers to Shell?

38. The asterisk at the bottom of the "Comprehensive RMA Chemical List", August 8, 1985 only applies to wheat rust. Other compounds also have an asterisk; what is it supposed to signify?

39. A table of contents would be helpful.

Andrew File

COLORADO DEPARTMENT OF HEALTH

Richard D. Lamm
Governor

Thomas M. Vernon, M.D.
Executive Director

July 9, 1986

Colonel W. Quintrell
Deputy Program Manager
Dept. of the Army
AMXRM-EE, Bldg. 4585
Aberdeen Proving Ground
Maryland, 21010-5401

Re: RMA Chemical Index Draft Final Report

Dear Colonel Quintrell:

Enclosed are our general comments on the draft RMA Chemical Index. The reference is an impressive compilation of the 666 chemical compounds associated with operations and disposal activities at RMA. Much more documentation on the specific use, disposal and toxicologic properties of many of these chemicals is being collected in the ongoing RI/FS and litigation activities. We therefore recommend that the document remain as a draft at least until completion of the CERCLA studies.

If you have any questions on the attached comments please contact Mr. Chris Sutton with the Water Quality Control Division.

Sincerely,

Tom Looby

Thomas P. Looby
Remedial Programs Director

TPL:CS/ras

cc: Howard Kenison, Colorado Attorney General
Bob Duprey, Region VIII, U.S. EPA
Chris Hahn, Shell Chemical Co.

4210 EAST 11TH AVENUE DENVER, COLORADO 80220 PHONE (303) 320-8333

REVIEW OF THE RMA CHEMICAL INDEX
PREPARED BY GERAGHTY AND MILLER, INC.
APRIL 1986

1. Why is the list of analytic parameters for the soils investigations characterized as a "Hit List" or the parameters in the ground (and surface) water monitoring program as the "Potential for Migration" list? Many other compounds have the "potential for migration" than those currently being analyzed in the water monitoring program. Other transport mechanisms exist (such as windblown deposits, biota and human activity, etc.) that will cause the migration of chemical contaminants. The lists of analytic parameters were prepared incorporating laboratory capabilities, economics and other factors besides the potential for their presence in soil (hits) or the ability to migrate in groundwater. We recommend that the titles of these lists in this reference do not overstate what they represent.

2. The criteria listed on Pg. 3 for inclusion of a specific compound in the reference should also be if the chemical is identified in the "unknown chemical" ID program in the remedial investigations of soils, sources or water at RMA.

3. How were the specific levels selected in the interpretation of low, moderate or high production and disposal volumes of chemicals at RMA. Were they based on some percentage of the total volume of materials generated or disposed? Does the value reflect an estimate of the weight of materials contaminated by a specific chemical (such as Mustard plant facilities) or is it solely an approximation of the quantity of a chemical that cannot be accounted for (product loss reports) in the records? Why is the level for "moderate" disposal volume almost twice the quantity of a "moderate" production volume? More discussion is needed to support the criteria proposed that the disposal of 700,000 lbs. of any chemical regardless of toxicity or persistance, was a "moderate" disposal volume at RMA.

4. An explanation is needed in the reference to define the environmental persistance assessment. Is this based on a chemical contaminant's persistence in biologically active soils, in the air, in groundwater systems or surface water systems? Or does this value represent an attempt to integrate a chemical compound's persistence under all conditions?

5. There are many inconsistencies, blanks and unclear representations made in the Chemical Matrix Table. Overall, we do not concur with a substantial amount of the information and interpretations made in the Chemical Matrix Table and we would recommend that it be removed from the index or modified extensively. Some of the specific problems are identified in the previous comments and other problems are discussed below:

   A) The Chemical Matrix table has a category titled "IN RMA ENVIRONMENT" and the explanation is that if the chemical is found in RMA environment above an ambient concentration the box would receive an X. There is no time reference, so it implies that a chemical either was or could be found at RMA at any time, in any sample and for any reason such as a spill or intentional disposal. Given this broad interpretation every one of the 666 chemicals either was or could be "found in the RMA environment."

Many chemicals that have been analytically identified in the media at RMA are not indicated in the column as being "found". We recommend that this column be eliminated from the matrix since it does not provide useful information and it is frequently inaccurate.

B) There should be two columns for volume, one representing disposal and one representing production or presence of a chemical at RMA. Again there is no time reference employed so we must assume that the production volumes signify that during the 44 years of operation at RMA, the total cumulative quantity of the chemical handled or generated does not exceed the criteria.

C) The production volume information doesn't appear in the table for many compounds. The disposal volumes for many compounds are not consistent with information presented in the index. For example, in the first five chemicals on the list, two show "Low" disposal volumes, acetaldehyde and acetaldoxime. The index in the next section shows 3.6 million lbs. of acetaldehyde and 2.4 million lbs. of acetaldoxime were disposed in Basin F. Since both quantities are obviously in excess of the 720,000 lb limit for high volume disposal, the table should have represented them as "H" or high volume disposed. In addition, a very high (VH) disposal category would also need to be used for compounds such as acetic acid where an estimated 22 million lbs. were disposed.

D) Another category that requires further explanation is the "Assignment" category. For instance acetone and methylene chloride are shown as being attributable only to Shell. These are such common industrial solvents that it seems unlikely that no information exists that would indicate the Army used and disposed of acetone or methylene chloride over the past 40 years.

6. The Chemical Index is a necessary single reference that will consolidate the pertinent physical and historical information on the specific chemicals used and disposed at the Arsenal by the Army and its lessees. The format is acceptable but there should be much more detail on physical and chemical properties of each substance and specific toxicologic information should be included when available. Again there are inaccurate statements and inconsistencies between the index and the previous matrix table. More discussion on the "assignments" is needed and justification or referencing for the information concerning production/use/disposal and reported quantities is needed. The Index as presented is a good beginning but significantly more detail should be included to finalize the documents. Due to the length and volume of information present in the Index, we recommend the document remain as a draft and that it be updated and revised as more information concerning the arsenal contaminants is generated by the ongoing CERCLA studies and litigation activities.

CS/ras-4539D

Comments with Responses to the April 1986 RMA Chemical Index

USEPA, REGION VIII COMMENTS TO THE APRIL 1986 CHEMICAL INDEX WITH RESPONSES

1) Information is now listed and organized for each compound by only one of its common names. A cross referencing index with each compound's scientific name, chemical formula, and Chemical Abstract Service (CAS) number would be very useful.

Response: The CAS registry number has been added to each entry. However, preparing a cross referencing index for all entries requires a significant effort. Since the Index is not intended to be an all-inclusive research document, this type of information is inappropriate for inclusion. The Index serves as a reference document which lists chemicals associated with RMA activities and provides information to support further research. The CAS numbers allow easy access to many standard reference sources.

2) Reference to specific toxicological, chemical, and fate information would also be helpful.

Response: The Index is not intended to be an all-inclusive research document and as a result, the inclusion of specific studies is inappropriate. However, generalized toxicological, chemical and fate information is included.

3) It would be extremely useful if the information were available in computerized form, so that cross references and data comparisons and checks could be quickly made. One application would be to define parameters required to quantitatively identify one or more of the "tentatively identified organics" from the GC/MS analyses.

Response: Although computerization would be beneficial, the benefit would not be cost-effective in response to the effort involved. The format of the revised Index has been selected to increase the usefulness and manageability of the Index.

SHELL OIL COMPANY COMMENTS TO THE APRIL 1986 RMA CHEMICAL INDEX WITH RESPONSES

1. The first paragraph of the Index contains a statement of intent to provide the user with pertinent information regarding the "chemical's production, use, disposal, and environmental impact to the extent that the information is available." It would be appropriate to add "toxicity" to the list since toxicological information is included in the Index and Matrix.

Response: We concur; toxicity has been added to the listing.

2. We suggest that the introduction acknowledge all facets of remediation, not just chemical decontamination. Chemical decontamination is but one of the many facets of remediation on the RMA. For example, consider UXO's, removal of large quantities of concrete, demolition of buildings and processing facilities, etc.

Response: We concur and text has been edited accordingly.

3. It is unclear whether the "Hit List" and the "Migration List" are minimum lists of intended analytes to which other chemical names could be added for specific areas of the site, or whether they are the ultimate lists for which the analyses for any given sample will be selected.

Response: Due to the ambiguous nature of these lists, they have been removed. They have been replaced by lists of target compounds for both the soil and ground-water monitoring programs of the remedial investigation.

4. The second paragraph of the introduction indicates that chemicals were added when research showed they were as-

sociated with RMA operations. What records were included in the research? Were any documents researched which indicate the likely breakdown or degradation products?

Response: Available records were reviewed, and all compounds associated with RMA operations were noted and included as entries in the 1986 version of the Chemical Index. All references used to compile the information in the entry are included in the Index bibliography. The compounds included in the Index are not only those compounds directly associated with operations but also all major degradation products, where documented.

5. It appears that many compounds which were used on the RMA are absent from the Index. For example:

Bromine
Lacquer thinners
Symmetrical 1,2-dimethyl hydrazine

A comparison to the total list of chemicals indicated to be present or handled on the RMA might possibly expand the list.

Response: All chemicals reported as "handled" at RMA were included in the Index. We have no information to support that bromine and symmetrical 1,2-dimethylhydrazine were used in any capacity at the Arsenal. Paint thinners were included in the 1986 Index, as well as many low molecular weight hydrocarbons which could have been used as thinners. If Shell would supply references regarding these

compound uses, we would include the entries accordingly.

6. The Army list notes that some of the compounds listed are possible degradation products of materials handled by Shell on the RMA. However, the Army has not chosen to list the potential degradation products of the materials they handled on the RMA. Shell had previously given the Army a list of potential surety degradation products along with an offer to provide analytical reference material.

Response: The list from Shell of potential surety degradation products was compared against all chemicals included in earlier versions of the Index. Those not previously considered were noted and the 1986 Index included all of these compounds. Potential degradation products of materials handled by the Army were included, when documented. If Shell has additional information, the entries will be annotated accordingly.

7. The Army was associated with at least the following compounds (and there may be others) which are not listed in the index:

Aluminum trichloride
Arsenic pentoxide
Button incendiary charge
Calcium fluoride
Calcium methylphosphate
Calcium orthoarsenate
Chlorovinylarsenious oxide
Daxad
Di-Di mixture
Diethyldodecane
1,2-dimethylhydrazine
Disodium methylphosphonate
n-Dodecane
Ethylene oxide
Freon
Hydrochloric acid

Isopropyl ester
Isopropyl methylphosphonochloridate
Lacquer thinner
M-2 thickener
Magnesium carbonate
Magnesium oxide
Methyl hydrazine
Napalm
2-Octylphthalate
Phosphate detergent
Polyvinyl alcohol
Potassium chlorate
Pyrotechnic incendiary mixture
Separan flocculant
Sodium arsenite
Sodium fluoracetate
Sodium isopropylmethyl phosphonate
Sodium phosphate
Ureabor
Miscellaneous greases and lubrication compounds which must have been used.

Response: A number of the compounds listed are included under synonyms in the 1986 Chemical Index. They are given below, with the applicable Index notation:

- Aluminum trichloride - See Aluminum Chloride
- Freon - See Freon 113
- Hydrochloric acid - See Hydrogen chloride
- Lacquer thinner - See Paint thinner
- M-2 thickener - See Thickener M2
- Magnesium carbonate - See Magnesium salt
- Methyl hydrazine - See Methylhydrazine
- Napalm - See Thickener M-1
- Potassium chlorate - See Chlorate ion

- Pyrotechnic incendiary mixture - See PT-1 mix

- Sodium phosphate - See Sodium orthophosphate

The remaining compounds are not included in the 1986 Index since they were not noted in any of the references reviewed. If Shell would supply references regarding these compounds, Index entries would be developed.

8. Contrary to statements in the Introduction, there appears to be chemicals listed in the "hit list" or "migration list" which are not currently included in the Army's sampling program. Please clarify why this is the case. The following are some of the chemicals in this category:

Atrazine
Azodrin
Bromide
1,1-Dichloroethane
1,2-Dichloroethane
1,2-Dichloroethylene
Dimethyl disulfide
Methylene chloride
Supona
Thiodiglycol
1,1,1-Trichloroethane
1,1,2-Trichloroethane

Response: From the listing given by Shell, the following compounds are included in the 360° Monitoring Program and/or the Phase I Program: Atrazine, 1,1-dichloroethane, 1,2-dichloroethane, 1,2-dichloroethylene, dimethyl disulfide, methylene chloride, Supona, thiodiglycol, 1,1,1-trichloroethane, and 1,1,2-trichloroethane. We have no information to determine why Azodrin or Bromide are

not included in any monitoring program. In addition, the hit and migration lists are removed from this version of the Index with lists of the target ground-water and soil analytical parameters for the RI provided instead.

9. What are the "core lists" referred to in the Matrix Key, first paragraph under "Toxicity Rating?" What are core lists used for?

Response: The "core lists" referred to were the Hit and Potential for Migration lists. However, these lists have been removed from this version of the Chemical Index; lists of the target compounds for the soil, and ground-water monitoring programs of the RI have been included instead of these "core lists."

10. In the detail sheets, one of the headings is "Included on priority lists." What is a "priority list?" What is a "priority list" used for? What is the basis of a "priority list?"

Response: The statement "Included on priority lists" referred to both the "Hit" and "Potential for Migration" lists. However, these lists have been removed from this version of the Chemical Index; listings of the target compounds for the soil and ground-water monitoring programs of the RI have been included instead.

11. Introduction, page 3, first bullet; the fact that a compound was produced in large quantities at RMA labels it as a suspected contaminant and as candidate for either the "hit list" or the "migration list." What logic was used to determine that high volume production items are necessarily on either list? Isn't it more appropriate to focus on the volume disposed of on the RMA since a good portion, if not almost all of some of the compounds produced, were sold or otherwise utilized?

Response: Both the hit and migration lists have been removed from the new version of the Chemical Index and were replaced by lists of the target compounds for the soil and ground-water monitoring programs of the RI. The criteria used to select these target compounds are the same as those used for the hit and migration lists. Also, although both production and disposal quantities were used for the compound selection process, greater importance was given to documented disposal quantities.

12. Introduction, page 3, first sentence states: "Selection of a compound to the lists may include some or all of the following criteria:". What logic was used to decide which criteria to use, and when to use them? What criteria were used to exclude a compound from one list that was already on the other list?

Response: Both the hit and migration lists have been removed from this version of the Chemical Index and were replaced by lists of the target compounds for the soil and ground-water monitoring programs of the RI. The stated criteria were used to select the target list of compounds for the soil investigation; the discussion of these criteria has been

expanded. The selection of the predominant criteria was subjective. However, the major requirements were the compound's toxicity and the quantities handled at RMA.

13. Other selection criteria for including compounds on the "priority" lists were stated in the detail sheets. Some of the criteria listed in the detail sheets are: natural constituent, tracer, spilled, widespread contaminant, mobile, and used. Why were these reasons not acknowledged in the introduction? Were any other selection criteria used but not mentioned in the Index? Were these criteria applied equally to all compounds, or did the source of the compounds have an impact on their selection?

Response: The criteria listed in the detail sheets (i.e., natural constituent, tracer, spilled, widespread contaminant, mobile, or used) were stated to give a more detailed picture of the compound's relation to RMA activities. These are not criteria for the selection of the target compounds. The entries and introduction text were revised to reflect this.

14. Cyanide is not included on either the "hit list" or the "migration list" even though the Index states it has been "detected in environmental samples," and "included in groundwater and Basin F fluid analysis." In contrast, cadmium, chromium, DDE, methylene chloride, 1,1-dichloroethane, 1,2-dichloroethane, DIMP, and lead to name a few, have been placed on one or both of the lists for the same reason that cyanide has been excluded.

Response: Both the "hit" and "migration" lists have been removed from this version of the Chemical Index, due to the inclusion criteria having many exceptions,

and are replaced by lists of the target compounds for the soil and ground-water monitoring programs of the RI. The criteria used to select the target analytes is clearer. However, cyanide is not included in either monitoring program.

15. We find many examples of confusing, conflicting and subjective logic in selecting compounds for the "hit list" and "potential for migration" lists. For example:

    a. Sodium and magnesium salts are short listed for the same reason that aluminum compounds are not.

    b. Acetylene tetrachloride is not short listed because it is "not stable in the environment." However, Vapona, Azodrin, Dimethyl disulfide, which are described as, and are, short lived are included on one or both lists.

    c. Antimony is not short listed because it has not been detected in environmental monitoring programs. Is the reader to assume all the compounds on the short list have been found in the environment above detectable limit?

    d. Octachlorocyclopentene, OCCP, is not short listed because "slight aqueous solubility suggests the compound is relatively immobile." Are no immobile or insoluble compounds short listed?

Response: Both the hit and migration lists have been removed from this version of the Chemical Index and are replaced by lists of target compounds for the soil and ground-water monitoring programs of the RI. None of the compounds listed above is included in the remedial investigation monitoring programs.

The exception is dimethyl disulfide, which is included in both programs since it has met the inclusion criteria.

16. Please clarify the logic for not selecting a compound to one of the two short lists. This explanation of selection logic needs to be part of the document proper.

Response: As stated previously, the hit and migration lists have been removed from the Index with the target compound lists added in their place. The target lists are more diagnostic of RMA activities than the hit and migration list. The criteria and logic for including compounds in the remedial investigation monitoring programs are explained in greater detail in the Introduction of this version of the Index.

17. The upper case letter "M" is used in the "reported quantities" field. Does it stand for 1,000 or 1,000,000?

Response: The upper case letter "M" represents 1,000 and all entries with this notation have been revised accordingly.

18. In the matrix, many terms represent a general class of compounds which cannot be given discreet characteristics, i.e., Atlox, GAFAC surfactants, Marasperse, Delta-keto, and Phenolics.

Response: There are unclear representations in the chemical matrix. It is not effective to condense the data

contained in the main body of the Index into a matrix. Hence, the matrix has been removed from this version of the Chemical Index.

19. In some instances both the compounds and synonyms are listed.

Response: This has been remedied in this version of the Chemical Index; all duplicate entries have been removed.

20. In many cases the ion of a metal is meant where the metal is stated. We need to come to agreement on a common technique to handle this situation.

Response: Entries are listed by the metal name or specific salt, when appropriate, and the entries are revised to reflect this; no cations are listed. The exception are those anions (i.e., chloride, sulfate, etc.) which are specifically analyzed in some monitoring programs. As with the metals, the specific salt will be listed, when appropriate.

21. "Karl Fischer Reagent" is a laboratory chemical. Does the army intend to list all laboratory chemicals? Shouldn't this be excluded?

Response: We agree that laboratory chemicals should be excluded from the Index. This entry and all other entries related to laboratory chemicals have been deleted.

22. Asbestos, a filter aid and insulator, is not included on the "hit list." According to the data sheet, asbestos (listed under "amianthus"), is "not considered to be a contaminant." In remediation of the RMA, however, asbestos might require inclusion in the remedial action plan.

Response: Although Asbestos was included in the 1986 Index, it has been removed from this version of the Index. It is a physical material, not an environmental contaminant. Materials of this type are not considered significant water or soil contaminants, and as such, it and all similar entries have been removed from this version of the Index.

23. Oleum is sulfur trioxide dissolved in concentrated sulfuric acid. None of these are likely to be "in RMA environment" as indicated in the matrix.

Response: We concur, and the entry has been revised accordingly.

24. Toxicity citations are based on secondary or tertiary sources and in many instances the work effort is incomplete. Sax or the Merck Index shouldn't be depended upon as the source of toxicity information. At the very least the widely available Registry of Toxic Effects of Chemical Substances, which can be obtained in hard copy, microfiche, or on-line with a computer modem, is the first choice. Further, in the Matrix summary which is designed to help readers (and by implication allow them to ignore the rest of the document) the toxicity column is filled in on a hit-and-miss basis which often seems prejudicial. We find it more than interesting that many of the Army's surety compounds don't seem to have any available toxicity information.

Response: Sax was used as the primary reference to avoid the interpretation of specific toxicology data. We

recognize that RTECS is widely available; however, the selection of which data to include and the interpretation of the types of data is subjective. The types of data required by each user would be different; their interpretation of the data would also be varied. In addition, the matrix has been removed from this version to avoid the inappropriate use of the matrix to avoid reviewing the actual Index entries.

25. The "Assignment" category in the report is potentially very misleading. What meaning does the label "Assignment" have? An unstated implication is that the organization to which the compound is "Assigned" also has the "blame" assigned. It would be more appropriate to substitute a more meaningful term such as "purchased by" or "produced by."

Response: The "Assignment" heading has been changed in "Information sources," and indicates which party is familiar with the technical data on a specific compound.

26. When the Arsenic heading lists the presence of Arsenic in Shell fuel oil on the same basis as the Army's Lewisite, the bias is overwhelming! Another example either of inaccurate work or of bias in this report is the listing of Portland Cement as a Shell-only item.

Response: All physical materials (such as Portland Cement) have been deleted from this version of the Chemical Index. We concur that there is a bias stating that both the Army and Shell used a compound but in different volumes. A review of all of the data

in the entry should indicate the predominant user. If Shell recommends a more efficient way to distinguish the varying usage quantities, we would review and evaluate that recommendation.

27. Some of the chemicals listed in the Index are assigned to the Army. However, the same chemicals assigned to the Army were not included in earlier interrogatory responses. Why?

Response: The interrogatory responses were prepared in 1984 while the Index was prepared in 1986. Additional information became available after 1984 to allow the assignment of additional compounds to the Army.

28. On what basis has Benzothiazole been assigned to Shell? We can find no basis for this; hence, it may be an Army compound.

Response: The references were rechecked and assignment to Shell operations was confirmed was based upon the use of benzothiazole in pesticide manufacturing. Since the Shell assignment was based on inference, it has been removed.

29. Chlorobenzene should be assigned to the Army.

Response: The references cited were reviewed and chlorobenzene is a compound used by the Army for cooling for thionyl chloride production.

30. Dimethyl methyl phosphonate (DMMP) is also a by-product from various Shell manufacturing processes.

Response: The entry for DMMP has been revised accordingly. The letter with the Shell comments is used as the reference. However, we would like more specific details (i.e., which processes it was associated with, estimated quantities generated, and disposal location). We request that Shell make references available.

31. The Army may have been associated with the following compounds which the Index doesn't attribute to the Army:

Atrazine (see chemical pesticide inventory)
Asbestos
Bis-(carboxymethyl) sulfone/sulfoxide
Bis-2-chloroethylmercapto (ethyl) ether
Bis (diisopropylaminoethyl) disulfide
Bis (diisopropylaminoethyl) sulfide
Borax/Boraxo powdered handsoap
Carbon, activated
Chloroacetic acid
Dieldrin (grasshopper control/chemical pesticide inventory)
2-Diisopropylaminoethyl sulfonate
Dimethyl arsinic acid
Dimethyl mercury salts (mercury salts and methyl mercury)
Dursban (chemical pesticide inventory)
Endrin (chemical pesticide inventory)
Fluoroacetic acid
Methyl arsonic acid
Methyl mercury salts
Methyl phosphonic acid, isopropyl ester
Portland cement
Rotenone
2,4,5 T-Silvex
Tetrachloroethylene
2,2'-Thiodiglycolic acid

Response: Fourteen of the compounds have been removed from the Index. They are as follows: asbestos,

bis(carboxymethyl) sulfone/sulfoxide, bis-2-chloroethylmercapto (ethyl) ether, bis(di-isopropylaminoethyl) disulfide/sulfide, Borax/ Boraxo powdered handsoap, activated carbon, dimethyl mercury salts, Dursban, methyl mercury salts, Portland cement, Rotenone, and 2,4,5 T-Silvex. Of the remaining compounds, we have no documentation to support that they were used by the Army. Based on conversations with former RMA personnel, the Army did use pesticides; however, no documentation regarding the types and quantities used were located. If Shell would provide documentation, the remaining entries would be annotated accordingly.

32. We have no records that Shell was associated with the following chemicals (suggest the references be checked):

Arsenic
Arsenic compounds
Diazinon
Trimethyl arsine

Response: The references cited for the above compounds have been reviewed. The arsenic compounds entry has been removed due to the ambiguous nature of the entry and the existence of entries for specific arsenic compounds. Of the remaining three entries, two compounds (diazinon and trimethyl arsine) have been removed from this version of the Index due to the lack of RMA-specific information.

Shell's assignment to arsenic was due to the detection of arsenic in a fuel analysis, and has been removed from this version of the Index.

33. Shell may have been associated with the following (suggest additional research to confirm):

4-Chloro-3-nitrophenyl methyl sulfone
Dowtherm A
Epon 828
Epon 1001
Ethylene glycol
Fuel oil #6
Gasoline
Hydroxybicyclo (2.2.1) hepta-2, 5-diene
7-Hydroxynorbornadiene
o-methyl methyl thiophosphonate
o-methyl methyl thiophosphonic acid
Nitric acid/sulfuric acid (mixed)
Paint thinner
Sodium bicarbonate
Sodium hypochlorite
Titanium

Response: Of the 16 compounds listed above, 11 have been removed from this version of the Index. Of the remaining five (Fuel oil #6, nitric acid/sulfuric acid, paint thinner, sodium bicarbonate, and sodium hypochlorite), we would like to review Shell's reference for specific details regarding their usage. Until then, the reference for Shell association is given by the letter from Shell with comments to the Index dated July 22, 1986 to Mr. Donald L. Campbell, Office of the Program Manager - Rocky Mountain Arsenal Contamination Cleanup.

34. When a compound is described as "persistent," what special attribute describes the threshold which must be exceeded? Under what conditions was the persistence determined?

Response: The persistence assessment was based on biological activity in soil and water. This was the major focus; however, volatility was also considered. The rating of the persistence data was based on the application of the substance to active growing season or the hydrolysis half life: Low for current crop (<60 days); Moderate for residual application (60 to 365 days); and High for possible carry-over to the next year's crops. However, the matrix has been removed from this version of the Index. Documented persistence data is included in the actual compound entries, when available.

35. The persistence data provided in the detail section is questionable. For example, the Index states the half life of naphthalene is less than one month and of low persistence. However, a CERCLA reference (40 CFR Part 300, 7/2/85, Appendix A) states this compound is "somewhat persistent."

Response: As discussed in the response to comment (34), the persistence was based on the application of the substance to an active growing season or the hydrolysis half life. A complete discussion of the criteria used for this determination is provided in the Introduction to this current version of the Chemical Index.

36. When a compound is indicated as being toxic, what special attribute describes the threshold which must be exceeded? Under what conditions was the toxicity determined?

Response: The toxicity determinations and ratings were taken directly from the sources referenced (specifically Sax and Merck). There was no interpretation of any actual toxicity data.

37. On page 4 of the Introduction, the ranges selected for "volume" of production and disposal appear arbitrary. What is the basis for the various cut-points? Are these annual figures or total figures? What data base was used to determine production and waste disposal volumes of Army compounds? Why didn't the Army provide this information in their interrogatory answers to Shell?

Response: The methodology was such that for each category (production or disposal) the available cumulative data regarding the quantities were sorted in increasing order and then divided into three groupings with the same number of compounds in each group. This methodology was used for the matrix notations; the matrix has been removed in this current version of the Chemical Index. All values were taken from the references cited; some references were only available after interrogatory responses were prepared.

38. The asterisk at the bottom of the "Comprehensive RMA Chemical List," August 8, 1985 only applies to wheat rust. Other compounds also have an asterisk; what is it supposed to signify?

Response: The asterisk notation was ambiguous (generally indicated trade names) and has been removed from this version of the Chemical Index.

39. A table of contents would be helpful.

Response: We concur; a generalized table of contents is provided in this current version of the Chemical Index.

COLORADO DEPARTMENT OF HEALTH COMMENTS TO THE APRIL 1986 RMA CHEMICAL INDEX WITH RESPONSES

1. Why is the list of analytic parameters for the soils investigations characterized as a "Hit List" or the parameters in the ground (and surface) water monitoring program as the "Potential for Migration" list? Many other compounds have the "potential for migration" than those currently being analyzed in the water monitoring program. Other transport mechanisms exist (such as windblown deposits, biota and human activity, etc.) that will cause the migration of chemical contaminants. The lists of analytic parameters were prepared incorporating laboratory capabilities, economics and other factors besides the potential for their presence in soil (hits) or the ability to migrate in groundwater. We recommend that the titles of these lists in this reference do not overstate what they represent.

Response: Both of these listings of analytical parameters have been removed and replaced by the target analyte list for the soil and ground-water monitoring investigations.

2. The criteria listed on Pg. 3 for inclusion of a specific compound in the reference should also be if the chemical is identified in the "unknown chemical" ID program in the remedial investigations of soils, sources, or water at RMA.

Response: The results of the "unknown chemical" identifications from the soil investigation have been reviewed. All pertinent information to the ARAR determination has been included in this current version of the RMA Chemical Index.

3. How were the specific levels selected in the interpretation of low, moderate, or high production and disposal volumes of chemicals at RMA. Were they based on

some percentage of the total volume of materials generated or disposed? Does the value reflect an estimate of the weight of materials contaminated by a specific chemical (such as Mustard plant facilities) or is it solely an approximation of the quantity of a chemical that cannot be accounted for (product loss reports) in the records? Why is the level for "moderate" disposal volume almost twice the quantity of a "moderate" production volume? More discussion is needed to support the criteria proposed that the disposal of 700,000 lbs. of any chemical regardless of toxicity or persistence, was a "moderate" disposal volume at RMA.

Response: The methodology was such that for each category (production or disposal) the available data were sorted in increasing order and then divided into three groupings having an equal number of elements. Toxicity or environmental fate data were not considered in the categorization. Also, cumulative totals were used. However, these classifications have been removed from this version and actual volumes are presented.

4. An explanation is needed in the reference to define the environmental persistence assessment. Is this based on a chemical contaminant's persistence in biologically active soils, in the air, in groundwater systems, or surface water systems? Or does this value represent an attempt to integrate a chemical compound's persistence under all conditions?

Response: The persistence assessment was based on biological activity in soil and water. This was the major focus, with volatility also being considered. The rating of the persistence data was based on application of the substance to active growing seasons and/or the hydrolysis half life: low for

current crop (<60 days); moderate for residual application (60 to 365 days); and high for possible carry-over to the next year's crops. However, the matrix has been removed from this version of the Index. Documented persistence data is included in the actual compound entries, when available.

5. There are many inconsistencies, blanks, and unclear representations made in the Chemical Matrix Table. Overall, we do not concur with a substantial amount of the information and interpretations made in the Chemical Matrix Table and we would recommend that it be removed from the Index or modified extensively. Some of the specific problems are identified in the previous comments and other problems are discussed below:

   A) The Chemical Matrix Table has a category titled "IN RMA ENVIRONMENT" and the explanation is that if the chemical is found in RMA environment above an ambient concentration, the box would receive an X. There is no time reference, so it implies that a chemical either was or could be found at RMA at any time, in any sample, and for any reason such as a spill or intentional disposal. Given this broad interpretation, every one of the 666 chemicals either was or could be "found in the RMA environment."

   Many chemicals that have been analytically identified in the media at RMA are not indicated in the column as being "found." We recommend that this column be eliminated from the matrix since it does not provide useful information and it is frequently inaccurate.

   B) There should be two columns for volume, one representing disposal and one representing production or presence of a chemical at RMA. Again, there is no time reference employed so we must assume that the production volumes signify that during the 44 years of operation at RMA, the total cumulative quantity of the chemical handled or generated does not exceed the criteria.

   C) The production volume information doesn't appear in the table for many compounds. The disposal volumes for many compounds are not consistent with information presented in the Index. For example,

in the first five chemicals on the list, two show "Low" disposal volumes, acetaldehyde and acetaldoxime. The index on the next section shows 3.6 million lbs. of acetaldehyde and 2.4 million lbs. of acetaldoxime were disposed in Basin F. Since both quantities are obviously in excess of the 720,000 lb. limit for high volume disposal, the table should have them represented as "H" or high volume disposed. In addition, a very high (VH) disposal category would also need to be used for compounds such as acetic acid where an estimated 22 million lbs. were disposed.

D) Another category that requires further explanation is the "Assignment" category. For instance, acetone and methylene chloride are shown as being attributable only to Shell. These are such common industrial solvents that it seems unlikely that no information exists that would indicate the Army used and disposed of acetone or methylene chloride over the past 40 years.

Response: We concur that there are unclear representations in the chemical matrix. It is not effective to condense the data contained in the main body of the Index into a matrix. Hence, the chemical matrix has been removed from this version.

6. The Chemical Index is a necessary single reference that will consolidate the pertinent physical and historical information on the specific chemicals used and disposed at the Arsenal by the Army and its lessees. The format is acceptable but there should be much more detail on physical and chemical properties of each substance and specific toxicologic information should be included when available. Again, there are inaccurate statements and inconsistencies between the Index and the previous matrix table. More discussion on the "assignments" is needed and justification or referencing for the information concerning production/use/disposal and reported quantities is needed. The Index as presented is a good beginning but significantly more detail should be included to finalize the documents. Due to the length and volume of information present in the Index, we recommend the document remain as a draft and that it be updated and revised as more information concerning the arsenal contaminants is generated by the ongoing CERCLA studies and litigation activities.

Response: With the completion of Phase I of the remedial investigation, the RMA Chemical Index is considered a final document. As stated previously, the Index is not intended to be an all-inclusive document and should not be regarded as such. Rather, the intent is for the Index to serve as a support document, particularly for the ARAR determination.

APPENDIX C

Evaluation of Nontarget Compounds Detected in RMA Soil and Ground-Water Samples

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Evaluation of Nontarget Compounds Detected in RMA Soil and Ground-water Samples

C.1 Historical Approach to RMA Nontarget Compounds Evaluation

Under the Phase I Remedial Investigation (RI) program, nontarget compounds (nontargets) had been reviewed on a site-by-site basis to determine whether additional compounds warrant investigation in the Phase II site investigation program. The nontargets were tentatively identified from the analysis of RI soil samples using gas chromatographic/mass spectrometric (GC/MS) techniques.

GC/MS techniques produce a gas chromatogram and a mass spectrum for each separated compound of sufficient concentration. The spectra obtained from the samples were compared with those stored in the computer library and the three with the best match were recorded. This method was applied to all compounds, and GC peaks with an area response greater than 10 percent of the internal standard's response were identified. The spectral identifications were further reviewed by the analyst to produce a final identification based on analytical experience and "best fit" of the data. In cases where spectral information was less complete, a

structural skeleton and general compound class were reported in generic fashion. For example, identifications such as "C7 alkane" or "C12 alcohol" have been provided for these situations.

During the course of the laboratory analyses, laboratory personnel alerted RI Project Managers whenever samples were high in oil or similar substances that might interfere with the chemical analyses. Managers were also alerted when sample dilution affected the lower reportable concentrations of the analytes.

The identified nontarget compounds were labeled using their relative retention times as referenced to the internal standard. Nontarget compounds detected in the volatile analyses were labeled by multiplying the relative retention time by 100. For example, a volatile compound with a relative retention time of 1.33 would have been labeled as "UNK133." Semivolatile compounds were labeled using the same convention and then adding 500 to create the label (i.e., a semivolatile retention time of 1.05 would result in a label of "UNK605"). The results of these identification procedures were summarized and included in each site report; they are labeled as "Tentative Identification of Nontarget Compounds in Site XX-YY." This information was developed for each borehole. These "UNKXXX" values were used for all

tentatively identified compounds; chemical name designations were made when possible.

All analytical measurements are subject to error from interference. Therefore, guidelines were established for those instances when nontarget compounds occurred in the method blank, as well as in the individual samples. Field samples with concentrations of nontarget compounds less than or equal to two times the corresponding values in the method blank were not reported. For these samples, the basic information of the sample was entered into the nontarget summary table in the site report and "none detected" was added to the comments column. For those field samples with concentrations of nontarget compounds greater than two times the method blank, the concentration reported was the value measured for the field sample less the value for the method blank.

Where nontarget compounds were above the blank criteria, but were suspected of being attributable to laboratory interference, an annotation indicating that the compound was a "suspected laboratory contaminant" was made in the comments column of the table listing the nontarget compounds. A comment of "possible column bleed" indicated that a compound detection was likely the result of column bleeding of silicon compounds.

As a result of the special explanations for the presence of certain chemicals, additional comments were required to explain why a compound was not recommended for study during Phase II. One or several of the following comments may have been used to describe a nontarget detection:

- o No positive identification.
- o Surfactant.
- o Plasticizer (note: all phthalate and adipates will have this comment).
- o Derived from natural products. ✓
- o Suspected laboratory contaminant.
- o Low concentration.
- o Low frequency of occurrence. ✓
- o Ubiquitous.
- o Relatively low toxicity.
- o Possible column bleed.
- o None detected. ✓

The nontargets tentatively identified at each site in the RI program were reviewed using the procedure described above. The Phase II investigation requirements (samples collected and the parameters for analysis) were determined from these Phase I data and from the site history.

C.2 Current Approach to RMA Nontarget Compound Evaluation

The predominant difference between nontarget review of Phase I of the RI and this current review process is that this procedure evaluates the tentatively identified nontarget compounds on a RMA-wide basis. The objective of this nontarget contaminant evaluation is to determine whether there are specific chemicals detected in the RI surveys (both soil and ground-water) which should be considered for potential inclusion in the list of target chemicals for the contamination and endangerment assessment programs at RMA.

Nontarget chemicals were identified from analytical results (using GC/MS techniques) of RMA soils (Ebasco, ESE) and ground-water data (ESE). The approach used in evaluating which chemicals would be considered for potential inclusion on the target list is presented in a flowchart in Figure 1 and consists of the following six steps:

1. The raw data base was reviewed, edited and corrected for entry errors and inconsistencies in format.

2. The data were sorted and presented in decreasing order according to frequency of occurrence (number of hits). Ranges were assigned to both concentration (greater than 100 micrograms per gram [ug/g], 100 to 50, 50 to 10, 10 to 5, 5

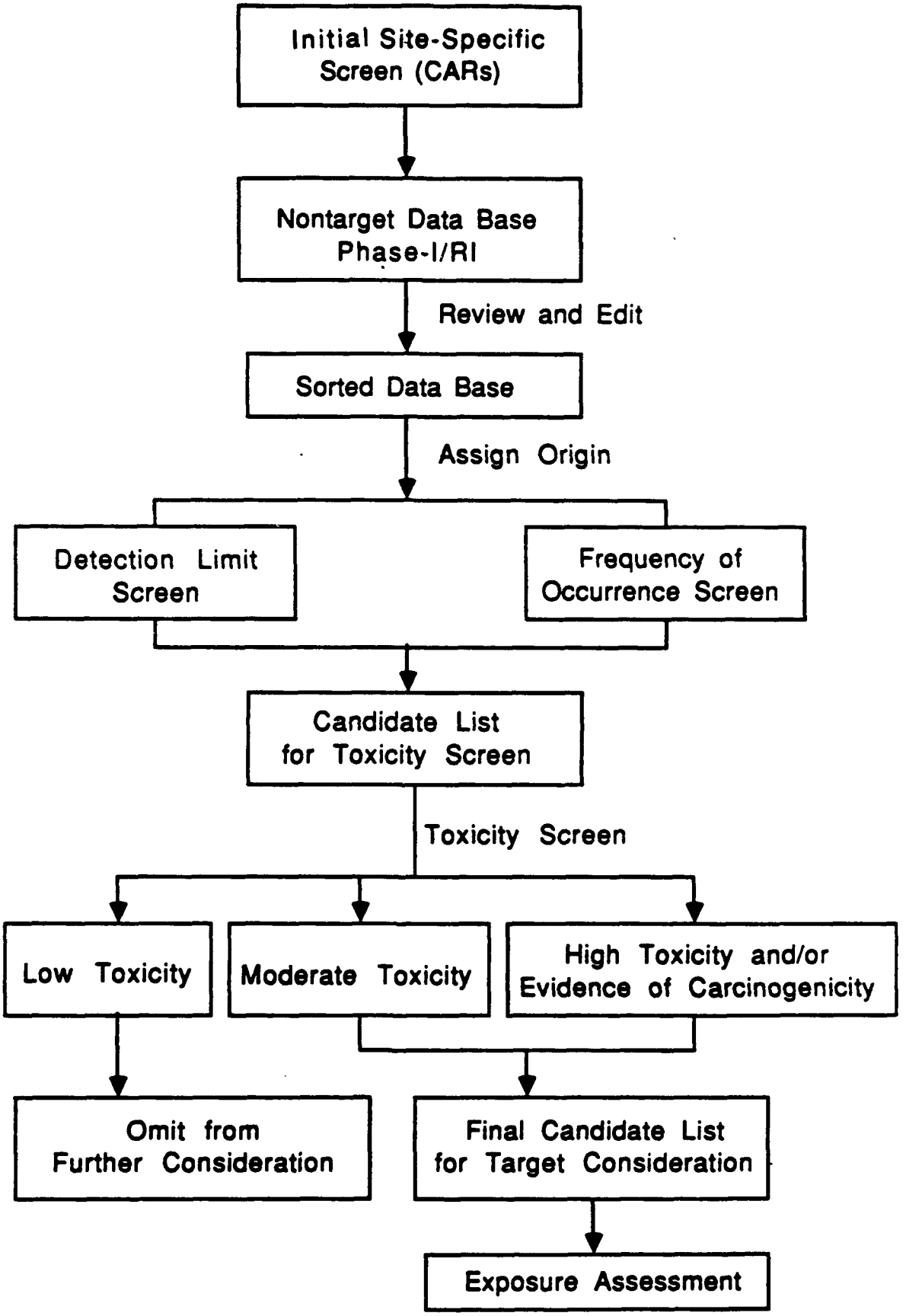

FIGURE 1. FLOWCHART DEPICTING THE NONTARGET EVALUATION PROCESS

to 1, and less than 1 for concentrations) and frequency (greater than 50, 50 to 10, 10 to 3, 3 to 1 for frequency).

3. The sorted data were reviewed, and the likely origin of the chemical was designated: N, for naturally occurring compounds; F, for fuel components; AR, for RMA-related chemicals; UB for ubiquitous anthropogenic compounds; and L, for laboratory contaminants. The rationale for grouping the nontargets according to the above designations is summarized below.

Naturally Occurring Compounds - Long-chain fatty acids, fatty acid methyl or ethyl esters and long-chain alcohols are all considered to be natural products. The compounds may also represent oxidation products or biodegradation products of the original compound.

Fuel Components - These consist primarily of polynuclear aromatic hydrocarbons (PAHs). The simple ones are made of fused benzene rings, such as anthracene, pyrene, and naphthalene; they are components of fuel oil, bituminous material, and some types of natural organic matter. These materials are also products of combustion. Because combustion was used to dispose of materials on the site and because it is likely that the PAHs come from either fuel or combustion sources, these compounds are considered to be related to RMA activity;

however, they are also considered separately from other RMA-related compounds. More complicated polycyclic compounds, which are noted as having seven, eight, or nine carbons in the ring or rings with nitrogen, oxygen, or sulfur, are also likely to be compounds coming from petroleum or bituminous products, as are the long-chained paraffinic hydrocarbons.

RMA-Related Chemicals - There are four major groups of chemicals that are considered to be related to RMA activities. These are brominated organics, chlorinated organics, organophosphorous compounds, and organosulfur compounds. The chlorinated organics, whether aliphatic or aromatic, are anthropogenic since there are essentially no natural chlorinated products. For the purpose of these screening evaluations, it is assumed that all the chlorinated organics are associated with historical RMA-activities even though some of these may be the result of anthropogenic background contributions. The norbornadiene structure is associated with Shell-manufactured pesticides.

Ubiquitous Anthropogenic Compounds - This grouping primarily consists of phthalate esters. They are detected in the soil and water of developed areas since they are produced in great quantities (estimated at over 1

billion pounds annually) and are incorporated into virtually every consumer product category (Menzer, 1986). Even though phthalate esters have been detected in many RMA soil and ground-water samples, they are not included as potential target analytes due to their common occurrence in the environment of all developed areas.

Laboratory Contaminants - Compounds which were identified by the laboratories as possible analytical interferences were grouped separately.

4. The chemicals resulting from the screening in Steps 1 through 3 were then reviewed to determine which should be subjected to a screen of available toxicological information. Four screening criteria addressing the compound designation, identification as a specific compound, concentration, and frequency of detection were used to make these determinations. Criteria are presented below for soil and ground water.

Soils - The screening criteria considered are as follows: (a) Only compounds designated as RMA-related or as fuel components were examined. (b) Only completely identified compounds (specific compounds) were used. For example, if only a generic identification was provided (due to inadequate spectral matching) the compound was eliminated from further consideration. (c)

Only compounds at concentrations greater than the reporting limit were considered further. Nontargets detected at concentrations close to the reporting limit (where there is a low signal-to-noise ratio, or low resolution), yield mass spectra that are not definitive enough to justify further consideration of the compound. (d) Nontargets occurring in greater than 5 percent of the analyzed samples were identified. For some chemicals, data on the total number of samples analyzed in soil were not available, so a frequency could not be computed. For those chemicals, an occurrence of greater than three "hits" (detections above the reporting limit) was used as the cut-off point.

Ground-water - For ground-water constituents, the soil nontargets evaluation criteria (a), (b), and (d) were also used for the ground-water nontargets. All compounds with concentrations measured within the range of the target chemical detection limits (approximately 5 to 15 parts per billion [ppb] for water-soluble targets and 0.05 to 0.10 ppb for hydrophobic targets) were noted for potential inclusion on the target list and only if the frequency criteria were also satisfied.

The list of chemicals which resulted from this screening process is presented in Table C-1.

5. A review of the readily available toxicological information was conducted for each chemical satisfying Steps 1 to 4 to determine potential toxicity and carcinogenicity. Chemical-specific toxicity data were compiled for each chemical from the National Institute for Occupational Safety and Health (NIOSH) Registry of Toxic Effects of Chemical Substances (RTECs 1983-1984). The chemicals' potentials for carcinogenicity were also determined from RTECs, where available. The carcinogenicity assignments reported in RTECs are based on reviews of the literature, as summarized by the International Agency for Research on Cancer (IARC), and on carcinogenicity studies conducted by the National Cancer Institute (NCI) and the National Toxicology Program, both divisions of the U.S. Department of Health and Human Services.

Chemicals were assigned both a carcinogenicity and a toxicity score based on the data available from the sources discussed above. Carcinogenicity scores were determined by ranking a chemical according to the strength of the evidence for carcinogenicity as given in the following designations:

Score	Strength of Evidence
3	Definitive evidence - human
2	Sufficient evidence - animal Limited evidence - human

1	Limited evidence - animal Inadequate evidence - human Inadequate evidence - animal No information on carcinogenicity

A score of 1 was also used as a default value for those chemicals where information on the potential for carcinogenicity was not available. No attempt was made to assign scores on the basis of structural similarity to other designated carcinogens.

Toxicity categories were assigned to each chemical based on acute oral, dermal, and inhalation toxicity information for experimental animals and/or acute toxicity data for humans, as available. In all cases, where data were available for more than one exposure route, those data which yielded the most conservative toxicity score were used. The criteria for determining the designations from acute toxicity data are presented below.

Toxicity Score	Oral LD_{50} (mg/kg)	Dermal LD_{50} (mg/kg)	Inhalation LC_{50} (ppm)
4	< 50	< 200	< 0.05
3	50 - 500	200 - 2,000	0.05 - 0.5
2	500 - 5,000	2,000 - 5,000	0.5 - 5
1	> 5,000	> 5,000	> 5

The basis for the acute criteria can be found in 49 Federal Register, Part 188, 37981-37982, Wednesday, September 26, 1984, "Acute Hazard Precautionary Statements" as proposed under the Federal Insecticide, Fungicide and

Rodenticide Act (FIFRA). Toxicity scores 3 and 4 represent more highly acutely toxic chemicals, while scores 1 and 2 represent chemicals of moderate or low toxicity. The toxicity categories set forth under FIFRA are consistent with the toxic categories specified in other federal statutes, including the Federal Hazardous Substances Act and the OSHA Hazard Communication standard. As a matter of perspective, under FIFRA, a chemical with toxicity scores of 3 or 4 should not be available to the general public for domestic use.

No attempt was made to assign toxicity scores based on structural similarity to other designated chemicals. Rather, if no toxicity information was available for a chemical, then the compound was not considered further unless data on carcinogenicity indicated otherwise.

Toxicity and carcinogenicity data were not available for a large proportion of the chemicals listed in Table C-1. Chemicals for which both a toxic and carcinogenic score were designated are listed in Table C-2.

6. Chemicals identified from Step 5 as having a low designated toxicity (i.e., toxicity category of 1) and inadequate or unknown evidence of carcinogenicity (i.e., carcinogenic ranking of 1) were not considered further. The candidate list of nontargets for potential inclusion as an Endanger-

ment Assessment (EA) target analyte that resulted from this screening procedure represents chemicals of moderate and high toxicity and/or those with sufficient evidence of carcinogenic activity in animals or humans.

The nontargets listed in Table C-3 constitute those chemicals which were selected for potential further consideration in the EA. The decision regarding their inclusion in the target list for a future detailed evaluation will depend on the following criteria:

a) They are the dominant contaminant at a given source or source area, i.e., their frequency of occurrence and concentration are similar to or higher than the values determined for the target constituents.

b) They occur with target contaminants at a given source or source area.

c) Enough information is available to determine if a chemical may pose a hazard at a given source or source area.

The above criteria will be considered as part of the source-by-source exposure assessment. At that time, a determination will be made regarding the designation of a non-

target contaminant as a significant contaminant for that source or source area. This determination will be consistent with the evaluation procedures for the development of action levels and response objectives for the target contaminants to be performed under the Integrated Endangerment Assessment (IEA).

REFERENCES

Menzer, R.E. and J.O. Nelson. 1986. Water and Soil Pollutants. IN: Cassarett and Doull's Toxicology. The Basic Science of Poisons. Third Edition. C.D. Klassen, M.O. Amdur and J. Doull, Editors, Macmillan Publishing Company, Inc., New York.

Office of the Federal Register, 1984. Volume 49, Code of Federal Regulations, Part 188, Acute Hazard Precautionary Statements, September 26, 1984, pp. 37981-37982.

Table C-1 Soil and Ground-Water Nontarget Compounds for Which Toxicology Data Were Reviewed

Soil Nontargets Compounds

Acenaphthylene

Anthracene

1,1'-Biphenyl

bis(2-Methylpropyl)ester-2-butenedioic acid

Bromocyclohexane

2-Butoxyethanol

Butyl-p-toluene sulphonate

Chlordene

Chlorocyclohexane

2-Chlorocyclohexanone

1-Chloro-(4-methylsulfonyl)benzene

2-Cyclohexen-1-ol

2-Cyclohexen-1-one

1,3-Cyclooctadiene

1,3,5,7-Cyclooctatetraene

1,3-Cyclopentadiene

Decahydro-2-methyl naphthalene

1,2-Dichloro-3,4 bis(dichloromethylene)cyclobutane

Dichlorodifluoromethane

1,3-Dichloro-2-propane

o,o-Diethyl-o-methyl phosphorothioate

Dimethyl phenanthrene

Dioctyl adipate

Dimethylnaphthalene

Table C-1 Soil and Ground-Water Nontarget Compounds for Which Toxicology Data Were Reviewed

Soil Nontargets Compounds

Dimethyltetrahydromenthano indene

2,2'(1,2-Ethane diyl-bis)oxybis ethanol

Ethyl cyclohexane

Ethylmethyl azulene

Fluoranthene

9-H-Fluorene

Fumaric acid, diisobutyl ester

Hexachlorobenzene

1,1,2,3,4,4-Hexachloro-1,3-butadiene*

Hexachloroethane

1,2,3,4,7,7-Hexachlorobicyclo(2,2,1)hepta-2,5-diene

Hexachlorobicycloheptene

Hexandiocic acid,mono(2-ethylhexyl)ester

Hexane

4-Hydroxy-4-methyl-2-pentanone*

2-Hydroxy-1-phenyl-ethenone

Methyl cyclohexane

Methyl naphthalene

1-Methyl-1,3-cyclopentadiene

Methylcyclopentane

2-Methylcyclopentanol

2-Methylcyclopentanone

4-Methyl-4H-1,2,4-triazole

Table C-1 Soil and Ground-Water Nontarget Compounds for Which Toxicology Data Were Reviewed

Soil Nontargets Compounds

Nonanedioic acid, dibutyl ester

Nonanedioic acid, diester

Octachlorocyclopentene

9-Octadecanamide

Octadecanoic acid,2-methylpropylester

Octadecenol

endo,exo,endo-Octahydro-dimethane-benze(f)indene

1,1'-Oxybis benzene

Oxybis ethanol

Pentachlorobiphenyl

Pentachloro(trichloroethenyl)benzene

Pentadecane

2-Pentanone

Phenanthrene

Phosphoric acid, tributyl ester

Phosphoric acid, triphenyl ester

Pyrene

Tetrazotricyclodecane

Tetrachlorobenzene

Tetrachlorocyclopentene

1,1,2,2-Tetrachloroethane*

3A,4,7,7A-Tetrahydro-4,7-methano-1H-indene

Trichlorobenzene

Trichlorocyclopentene

Table C-1 Soil and Ground-Water Nontarget Compounds for Which Toxicology Data Were Reviewed

Soil Nontargets Compounds

Trichloropropene

3,3,3-Trichloropropene

1,1,2-Trichloro-1,2,2-trifluoroethane

Trimethyl benzene

Trimethyl naphthalene

Ground-Water Nontarget Compounds

Caprolactam

1,3-Dithiolane-2-thione

Hexachlorobutadiene*

4-Hydroxy-4-methyl-2-pentanone*

Methylsulfoxylbenzene

Octadecanamide

1,1,2,2-Tetrachloroethane*

2,6,10,14-Tetramethylhexadecane

2,6,10,14-Tetramethylpentadecane

2,6,10-Trimethyl pentadecane

Note: Chemicals common to soil and ground water are indicated by [*].

Table C-2 Toxicity and Carcinogenicity Rankings for RMA Nontarget Compounds

Explanatory Notes

[a] The chemical was detected in one or both of the following media:

S = soil
GW = ground water.

[b] Acute toxicity data were not adequate (NA) to determine a toxicity category.

[c] Data used are for 1,1,2,3,4,4-hexachloro-1,3-butadiene.

[d] Data used are for 2-methyl naphthalene.

[e] Toxicity category based on human acute lethality data.

[f] Data used are for the 1,2,3,4 isomer of tetrachlorobenzene.

[g] Data used are for the 1,2,4 isomer of trichlorobenzene.

[h] Data used are for the 1,2,3 isomer of trichloropropene.

Table C-2 Toxicity and Carcinogenicity Rankings for RMA Nontarget Chemicals

Chemical Name	Media[a]	Toxicity Category	Carcinogenicity Ranking
Anthracene[b]	S, GW	NA	1
2-Butoxyethanol	S	3	1
Caprolactam	GW	3	1
Dichlorodifluoromethane	S	1	1
1,2-Dichloro-2-propanone	S	1	1
Dioctyl adipate	S	1	1
Fluoranthene	S	2	1
Fluorene[b]	S	NA	1
Fumaric acid, diisobutyl ester	S	1	1
Hexachlorobenzene	S	2	2
Hexachlorobutadiene[c]	S, GW	2	1
Hexachloroethane	S	1	1
Hexane	S	1	1
4-Hydroxy-4-methyl-2-pentanone	S, GW	2	1
Methyl cyclohexane	S	2	1
Methyl naphthalene[d]	S	2	1
1-Methyl-1,3-cyclopentadiene	S	2	1
Oxybis ethanol[e]	S	2	1
Pentachlorobenzene	S	2	1
2-Pentanone	S	2	1
Phenanthrene	S	2	1
Phosphoric acid, tributyl ester	S	2	1

Table C-2 Toxicity and Carcinogenicity Rankings for RMA Nontarget Chemicals

Chemical Name	Media[a]	Toxicity Category	Carcinogenicity Ranking
Phosphoric acid, triphenyl ester	S	2	1
Pyrene	S	2	1
Tetrachlorobenzene[f]	S	2	1
1,1,2,2-Tetrachloroethane	S, GW	2	1
1,1,2-Trichloro-1,2,2-trifluoroethane	S	1	1
Trichlorobenzene[g]	S	3	1
Trichloropropene[h]	S	3	1
Trimethylbenzene	S	3	1

Dermal
Inhalation
Ingestion

Carcinogenicity
3 definite evidence
2 ← sufficient ev. in animals
← limited ev. in humans
1

Toxicity
4
3 > moderate to low
2
1

Table C-3 Candidate List of Nontarget Compounds

Compound	Media of Detection
2-Butoxyethanol	soil
Caprolactam[1]	ground water
Fluoranthene	soil
Hexachlorobenzene	soil
Hexachlorobutadiene	soil, ground water
4-Hydroxy-4-methyl-2-pentanone	soil, ground water
1-Methyl-1,3-cyclopentadiene	soil
Methyl cyclohexane	soil
Methyl naphthalene	soil
2,2'-Oxybisethanol	soil
Pentachlorobenzene	soil
2-Pentanone	soil
Phenanthrene	soil
Phosphoric acid, tributyl ester	soil
Phosphoric acid, triphenyl ester	soil
Pyrene	soil
Tetrachlorobenzene	soil
1,1,2,2-Tetrachloroethane	soil, ground water
Trichlorobenzene	soil
Trichloropropene	soil

[1] Listed as 2H-Azepin-2-one,hexahydro in Chemical Index.

Appendix D

Comments from the Organizations and the State and Responses to the May 1988 RMA Chemical Index

Comments from the Organizations and the
State to May 1988 RMA Chemical Index

USEPA - received June 20, 1988
Shell Oil Company - received June 20, 1988
U.S. Department of Interior, Fish and Wildlife Service -
received June 21, 1988
Colorado Department of Health - no comments received

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
999 18th STREET - SUITE 500
DENVER, COLORADO 80202-2405
JUN 15 1988

Ref: 8HWM-SR

Colonel W. N. Quintrell,
Program Manager
Office of the Program Manager for
Rocky Mountain Arsenal
ATTN: AMXRM-PM
Building E4460
Aberdeen Proving Ground, Maryland 21010-5401

Re: Rocky Mountain Arsenal, (RMA),
Chemical Index, Draft Final Report,
May, 1988.

Dear Colonel Quintrell:

We have reviewed the above referenced report and have the enclosed comments. Please contact Mr. Connally Mears at (303) 293-1528, if there are questions on this matter.

Sincerely yours,

Robert Duprey, Director
Hazardous Waste Management Division

Enclosure

cc: Thomas P. Looby, CDH
David Shelton, CDH
Lt. Col. Scott P. Isaacson
Chris Hahn, Shell Oil Company
R. D. Lundahl, Shell Oil Company
Thomas Bick, Department of Justice
David Anderson, Department of Justice
Preston Chiaro, EBASCO

REVIEW COMMENTS

DOCUMENT: Draft Final Report
Rocky Mountain Arsenal Chemical Index
Volumes I and II
May 1988
Prepared by EBASCO Team

1. Under the category: History of use, production, disposal, and quantities, there are possible discrepancies between the information reported here and that contained in applicable CARs. For example, at Site 1-13, eight samples contained toluene concentrations ranging between 0.4 and 30 ppm; the majority of these were collected in the vicinity of Building 514. The Phase I CAR for Site 1-13 does not provide a possible source for the observed toluene levels. However, the Chemical Index (this document) relates that 1,000 gallons of toluene were spilled at building 514 (in Site 1-13) in 1955. The source of historical information used in the Chemical Index should be better documented.

2. The EPA reserves the right to comment in the future on specific applications of the Chemical Index. For example, future research may affect understanding of persistence or toxicity of many of the compounds in the Index.

2/2

881297-2/2

Shell Oil Company

c/o Holme Roberts & Owen
Suite 1800
1700 Broadway
Denver, CO 80290

June 16, 1988

Office of the Program Manager
for Rocky Mountain Arsenal
ATTN: AMXRM-RP: CPT Andrew Kingery
Aberdeen Proving Ground, Maryland 21010-5401

Dear Captain Kingery:

We have reviewed the Draft Final Rocky Mountain Arsenal Chemical Index. Attached are detailed comments on certain sections of the Index. Our comments on the "Chemical-Specific ARARs for On-Post Operable Unit, RMA", Volume III of the Index, are being provided under separate cover.

We have two major concerns relative to the contents of the Army's Chemical Index. First, we previously provided you with a study titled "Ranking of Chemicals, Compounds, and Substances of Possible Significance at RMA, December 1986", in which we developed a ranking system for toxicity and carcinogenicity of all compounds handled on the RMA. We believe this ranking system incorporates generally accepted classification of hazard. Therefore, we still believe this is a valid classification system and should be utilized.

Second, we have significant concerns regarding the section of the Index titled "History of Use, Production, Disposal and Quantities". In the discussion portion of the Index, the authors explain that the information is not intended to be all-inclusive, but to "describe the relationship" of the compound to RMA activities. Also, the authors caution that the quantities presented are for comparison purposes and the available data are incomplete due to a lack of continuous record. We believe the Chemical Index should be a factual and accurate document due to its potential future use. We find that the Index contains numerous errors, especially in the history section.

The history section contains information regarding waste quantities and spill information that is based on selected data, not the complete available record, and many of the entries appear to be biased, incomplete, and not applicable to the RI/FS. In addition, much of the information presented has little historical basis to substantiate its validity. What is important to remediation is what is extant in the environment today, which is the objective of the RI/FS.

Accurate records exist in the Shell answers to the U.S. interrogatories and in Shell's monthly/quarterly operating summaries on the quantities of raw materials utilized and products and dates of manufacture. Additional information exists in Army records, which have been provided to Shell, in which the Army could expand its history section to a more complete and accurate record of materials produced, used, and disposed of on the RMA.

We question the usefulness of the substantial technical effort necessary to edit the historical section of the Index to produce a viable record. We believe Shell's technical effort could be more beneficial to the RI/FS process in other more important areas than trying to reconstruct an accurate historical record. We recommend that the history section of the Index be deleted. Please advise us within two weeks of receipt of this letter if you concur. Otherwise, it will be necessary for Shell to undertake a substantial effort to develop a more accurate historical record. If you need to discuss this issue further, please contact me at your earliest convenience.

Sincerely,

W. E. Adcock
For
C. K. Hahn
Manager
Denver Site Project

WEA:ajg

Attachments

cc: (w/attachments)
Office Of the Program Manager for Rocky Mountain Arsenal
ATTN: AMXRM-PM: Mr. Donald L. Campbell
Building E-4460
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Office of the Program Manager for Rocky Mountain Arsenal
ATTN: AMXRM-TO: Mr. Brian L. Anderson
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SHELL OIL COMMENTS ON THE ROCKY MOUNTAIN ARSENAL DRAFT FINAL CHEMICAL INDEX MAY, 1988

I. Comments on specific chemicals listed by primary name are located in Attachment A.

II. A list of chemicals recommended for removal from the Index are located in Attachment B with supporting comments.

III. A list of chemicals recommended for inclusion in the Index are located in Attachment C.

IV. Miscellaneous comments:

1. Page 4, Criteria #1 - There are no specifics provided to interpret the proposed definition of "large quantities".

2. Page 5, first paragraph - The statement in the third sentence lacks specificity. If it is not defined elsewhere in the text, it should be clarified, or removed. What is meant by "not obviously benign"?

3. Page 5, first paragraph - The last sentence overlooks that some technical aspects of the remedial program may well involve volatilization. Hence, volatilization should be considered.

4. Page 16, History of use, production, disposal, and quantities - The history section contains information regarding waste quantities and spill information that is based on selected data, not the complete available record, and many of the entries appear to be biased, incomplete, and not applicable to the RI/FS. In addition, much of the information presented has little historical basis to substantiate its validity. What is important to remediation is what is extant in the environment today, which is the objective of the RI/FS. Accurate records exist in the Shell answers to the U.S. interrogatories and in Shell's monthly/quarterly operating summaries on the quantities of raw materials utilized and products and dates of manufacture.

5. Page 10, Environmental Fate - The information provided in this section should be qualified because of the limitations inherent in the data and the references used to determine the environmental fate. Wide variations in conclusions can be drawn from the literature. For example, the conditions of persistence and degradation vary considerably depending on conditions of their deposition and environmental factors. Additionally, the environmental fate should provide meaningful information. Some sections have not, e.g., lead.

6. Page 11, Toxicity - The toxicity ratings proposed place many compounds in severe classification, which does not relate to what the public is familiar with as pertains to Class B poisons. The MKE system proposed earlier (Ranking of Chemicals, Compounds and Substances of Possible Significance at the RMA, December 1986) utilizes widely accepted definitions and is based upon more readily available LD/50 values. There are many compounds for which the Army has not located a Sax rating, illustrating the inadequacy of the approach selected. Why is there more than one Sax rating on chemicals?

   The response to Shell's comment Number 24 (See Appendix B - response to 1986 RMA Chemical Index) indicates the Army's wish not to interpret which toxicity data to list, if there is more than a single source, which can easily be resolved. We could agree on which data is most representative of the concern for remediation on the RMA and note it accordingly. Most of the data is going to fall within some prescribed area as indicated in the MKE report on ranking of chemicals. In some cases it may fall into two areas as the Sax rating does. This should not present the problem envisioned. As it currently stands, the Sax data base is incomplete and also has many missing data points.

7. Table 2, page 6 - Shell has a certified method available for trimethyl phosphate. (See note #6).

8. Appendix A, page 2 -

First Bullet - If physical materials are excluded, such as asbestos, where is this information to be listed?

Second Bullet - There are many duplications in the text that according to this item should be eliminated. For example, sulfate is a duplicate of many of the salts listed.

Fifth Bullet - There are several entries that are laboratory reagents as noted in the comments above.

ATTACHMENT A

COMMENTS ON SPECIFIC CHEMICALS FROM THE DRAFT FINAL RMA CHEMICAL INDEX MAY, 1988

Acetamide - Nudrin production was from 1973 to 1982.

Acetone - Army should also be listed on the information source.

Acetylene - What is the value of listing two years disposal of waste lime to lime pits?

Acetylene tetrachloride - Army should be listed as the source of information.

Adamsite - Army should be listed as the information source.

Aerozine 50 - If the two ingredients are listed as having a Sax rating of 3, why isn't the mixture rated as having a rating of 3?

Akton - The material was not produced from 1952-1974, only in 1967.

Aldrin - Effluent to Basin A until 1957. Shell objects to the classification of this compound as a probable human carcinogen. A forthcoming dieldrin risk assessment will discuss the toxicological aspects of aldrin/dieldrin.

Aldrite 4EC - Under formula: This is a 4-pound per gallon emulsifiable concentrate of aldrin in a solvent.

Allyl alcohol - This is not a raw material for the synthesis of DBCP.

Aluminum chloride - Wasn't this used in the production of thionyl chloride operations (see entry under aluminum hydroxide)?

Aluminum hydroxide - Army should be listed as the information source.

α-Amino-iso-butyronitrile - The disposal period was 1970-71.

Ammonia - Army should also be listed as the information source.

Ammonium chloride - Sold as a fertilizer in 1979-82.

Ammonium nitrate - Dates are not correct.

Arsenic - Has the Army analyzed its various fuel oil supplies for trace metals? There is no relationship between the arsenic contamination in Section 36 and RMA groundwater and the amount of arsenic found in Shell's No. 6 fuel oil.

Arsenic chloride - The wells near Basin F are not the only place that the monitoring program has detected arsenic; also section 36, and the South Plants areas.

Azodrin - This material was manufactured by Shell from 1965-1982. Information provided in the History section is particularly biased, incomplete and not applicable to the RI/FS.

Benzene - Benzene was not used past 1957 in aldrin, dieldrin and endrin manufacture. Where is the data on the Army's usage of this material? Why doesn't the information sources list lessee prior to Shell as benzoyl peroxide does?

Benzothiazole - We do not believe this compound was present in any Shell pesticides.

Bicyclopentadiene - (DCPD) - Since dicyclopentadiene has been the traditional nomenclature for this compound on the RMA, we recommend we continue its use. The disposal period did not extend past 1974. Monitoring history includes information on the Army's estimate of the size of a plume. What determines when the Army describes the size of a plume? Has this been done for all compounds? How does the Army know the origin of the plume described; i.e., how do they know if the material came from any particular place in Basin F, versus either the sanitary sewer, chemical sewer, or from Basin A?

Bis-carboxymethyl sulfone - Army should be listed as the source of information.

Bis-carboxymethyl sulfoxide - Army should be listed as the source of information.

Bis(2-chlorovinyl)chloroarsine - If the toxicity is comparable to Lewisite, why is there no toxicity rating?

Bromic acid, potassium salt - Shell did not handle potassium in the Dibrom or Nemagon process. Hence, it would not have been possible to generate this material as indicated.

2-Butoxyethanol - This is a common ingredient in automotive antifreeze solutions. Hence, both Shell and the Army should be listed as information sources.

Cadmium - Army sites have been found to contain cadmium. The Army should be listed as a source of information.

Calcium bromate - This material was not part of an effluent stream as suggested by the Army. Calcium was not incorporated as part of a neutralization agent by Shell in the manufacture of Nemagon. Shell should not be listed as an information source.

Calcium chloride - Also used by Army and Shell as road deicer; hence, both parties should be listed as information sources.

Carbon tetrachloride - Army should also be listed as the source of information.

Chloral hydrate - This material did not go to Lowry as indicated.

Chlordane - The reference to Julius Hyman should be changed to Shell.

Chlorinated paraffin - Should reference the disposal on the RMA in the laundry effluent.

Chlorinated phenol - Unless more definitive information is available, the information source should not list Shell.

Chloroacetaldoxime - The time period should be from 1973-1982.

Chloroacetic acid - This is a decomposition product of mustard. The Army should be listed as the source of information.

Chloroform - The history of Shell usage should extend to 1982.

2-Chlorovinylarsonic acid - Change "Assignment" to "Information Source".

2-Chlorovinylarsonous acid - Army should be listed as the source of information.

Chromic Acid - change "Assignment" to "Information Source". Army should be listed as the source of information.

Copper - Army should be listed as the source of information (see copper sulfate - history).

Cyclohexanone - Shell never disposed of this material in Lake Mary.

1,3-Cyclopentadiene - It was also used in endrin manufacture.

DDVP - This is not a process intermediate during Bidrin manufacture.

1,2-Dibromochloropropane - What is meant that contamination is above standard in Section 13? Shell objects to the classification of this compound as a probable human carcinogen. Toxicological information is available in a risk assessment previously provided by Shell.

1,1-Dibromoethane - If this material was used on the RMA, the Army should be listed as the information source.

2,2-Dichloroacetaldehyde - Shell should be listed as the information source.

1,2-Dichloroethane - We do not believe Shell was involved with this chemical. Therefore, the Army should be listed as the information source.

1,1-Dichloroethylene - This product was not handled by Shell. Therefore, the Army should be listed as the information source.

Dieldrin - The disposal quantity is overstated. A synonym is 497. Shell objects to the classification of this compound as a probable human carcinogen. A forthcoming risk assessment will discuss the toxicological aspects.

O,O-Diethylphosphorochloridothioate - A synonym for this compound is ethyl thio acid chloride (Ethyl TAC). The years of manufacture are 1964-1966.

O,O-Diethyl thionophosphonate - The formula is $C_4H_{11}O_3PS$.

2-(Diisopropylamino)-n-ethyl sulfonate - The Army should be listed as the information source.

Diketene - This compound was also used in the manufacture of Bidrin.

Dimethanonaphthalene - The formula is $C_{12}H_{14}$.

Dimethyl arsenic acid - The Army should be listed as the information source.

Dimethylmercury salts - The Army should be listed as the information source.

Dimethylnitrosamine - This material should be listed as a possible decomposition product of hydrazine. Refer to Army decision document on the closure of the hydrazine facilities.

O,O-Dimethylphosphorochloridothioate - A synonym for this material is Thio Acid Chloride (TAC). ETAC is the synonym for Ethyl Thio Acid Chloride.

Di-n-propylnitrosamine - If there is no information in the History section, this compound should be deleted.

Endrin - A synonym is 269. This was in the Army's inventory in the late 1970's as "Rid-a-Bird". Hence, the Army should be added as an information source.

Fluroacetic acid - This is a decomposition product of G.B. The Army should be listed as the source of information.

HCCPD impurities - Groundwater monitoring data suggest that the wastes are not migrating from the burial site.

Heptane - Was used in the manufacture of endrin.

1,2,3,4,7,7-Hexachlorobicyclo(2.2.1)hepta-2,5-diene - A synonym for this compound is 601.

Hexachlorobutadiene - The reference to Shell's leasehold in the Monitoring History should be replaced with South Plants area. The "Shell leasehold" is a disputed Army term which has not been legally established.

Hexachlorocyclopentadiene - The synonym for this is Hex. It is a raw material, not a process intermediate.

Isodrin - A synonym is 711.

Lead - Considering that the Army handled munitions containing lead azide, the Army should be listed as the information source.

Methane dichloride - Comments under History section are incorrect in that Shell was the contractor for the Army process and Army was owner of materials. Shell did use methylene chloride for a few years in the early 1960's as a solvent in the Azodrin process. Hence, Army should also be listed as a information source.

Methanethiol - The comment under the History section relative to disposal at Lowry is incorrect and needs to be retracted. Disposal dates for Basin F are 1973-1977.

Methanethiol, sodium salt - The comment under the History section relative to disposal at Lowry is incorrect and needs to be retracted. Disposal dates for Basin F are 1973-1977.

N-Methylacetoacetamide - Material was used 1965-1982. Disposal off the RMA is not applicable to the RI/FS; hence, this comment should be removed.

Methylamine - The period of use was 1965-1982.

Methylarsonic acid - Change "Assignment" to "Information Source". Since this compound is associated with Lewisite, shouldn't the Army be listed as the information source?

Methyl isocyanate - The use period should be extended from 1975 to 1982.

Methylmercury salts - The Army should be listed as an information source.

Methyl phosphonic acid, isopropyl ester - Since the Army used this material, why isn't the Army listed as an information source?

Methyl phosphonic dichloride - The History section should reflect that Shell was only a contract operator of the Army process using Army materials.

Methylthioacetaldoxime - The period of use should be extended from 1975 to 1982.

Monomethyl chloroacetoacetamide - The period of use should be extended from 1975 to 1982.

Monomethyl dichloroacetocaetamide - The period of use should be extended from 1975 to 1982.

4-Nitrophenol, sodium salt - A synonym is PNSP. This is a raw material for the manufacture of ethyl and methyl parathion.

3-Oxo-butanoic acid - The use period should be extended from 1975 to 1982.

Paint Thinner - We recommend this be dropped. Shell may have used incidental quantities. If paint thinner qualifies for inclusion, the Army should be listed under all chemicals with incidental usage, including a variety of pesticides.

Pentachlorophenol - We are not aware of this chemical in our manufacturing processes.

Peroxyacetic acid - This material was used prior to 1952 in dieldrin and endrin manufacture. After 1952 the material was formed in-situ and in the epoxidation reactions, and not isolated.

Peroxybenzoic acid - We do not believe this material was used in the manufacture of endrin.

α - Phenethyl alcohol - Should this be spelled: α-phenylethyl alcohol?

Phosgene - We do not believe this is a decomposition product of Dibrom. Shell should be removed from the information source listing.

Photodieldrin - In published work on Dieldrin photolysis in the gas phase Crosby and Moilanen (Crosby, D.G., and Moilanen, K.W., "Vapor-phase Photo-decomposition of Aldrin and Dieldrin." Arch. Environ. Contam. Toxicol, 2:62, 1974) observed a photodieldrin half-life of approximately ten days under artificial ultraviolet light. Photodieldrin removal reactions are probably dominated by a hydroxyl-initiated oxidation reaction sequence, as are those of most organic compounds, with reaction half-lives of 0.2 to 10 days (Darnell, et. al., 1970). Thus, photodieldrin would be expected to have a very short atmospheric lifetime.

Shell *nitrogen* solution - A synonym is 8-0-0-1S.

Shell poultry spray - The product contained Rabon Insecticide, xylene, phenol, and an emulsifier.

Sodium - The reference primary name should be sodium ion to avoid confusion with elemental sodium.

Sodium carbonate - The reference to off-site disposal should be removed from the text since it contributes nothing to the EA.

Sodium chloride - The reference to off-site disposal should be removed from the text since it contributes nothing to the EA.

Sodium hydroxide - Shell used this material as a process material in many of its processes to neutralize various materials. The reference to off-site disposal should be removed from the text since it contributes nothing to the EA.

Sodium hypochlorite - Used by Shell to destroy cyanide containing wastes.

Sodium sulfate - The reference to off-site disposal should be removed from the text since it contributes nothing to the EA.

Sodium sulfite - The reference to off-site disposal should be removed from the text since it contributes nothing to the EA.

Sodium thiosulfate - The Army agreed earlier to not list laboratory reagents due to the relatively small nature of any disposal. Therefore, this should be deleted.

Sulfonic acid - This is not the correct name for this compound.

Sulfur dioxide - Azodrin manufacture should be extended from 1975 to 1982.

Sulfuric acid - Shell used this material also in the manufacture of dieldrin, endrin, and DDVP.

Tetrahydrofuran - Purchased as a laboratory reagent. Should be removed from the listing since laboratory reagents by agreement are not to be included.

Thionyl chloride - Shell does not believe this material was used by Shell. The references are Army and not Shell. Where is the Army's basis for believing Shell used this material?

Trichloroacetic acid - Shell never produced Dursban; hence, this must be an Army chemical.

2,2',4'-Trichloroacetophenone - The formula is $C_8H_5Cl_3O$.

2,2',5'-Trichloroacetophenone - The formula is $C_8H_5Cl_3O$.

2,4',5'-Trichloroacetophenone - The formula is $C_8H_5Cl_3O$.

2,4,6-Trichlorotriazine - The information listed in the environmental fate is wrong. Cyanuric chloride reacts very rapidly with water and moisture in the environment, and is not stable in the environment.

Trimethyl phosphate - The period of use should be extended from 1975 to 1982.

Trimethyl phosphite - The period of use should be extended from 1975 to 1982.

Urea - The period of use should be extended from 1975 to 1982.

Xylene - This material was not used in the manufacture of endrin. Xylene was used in methyl parathion manufacture.

Zinc - If this was only used as a laboratory reagent, shouldn't it be deleted from the list?

ATTACHMENT B

CHEMICALS RECOMMENDED FOR REMOVAL FROM THE DRAFT FINAL RMA CHEMICAL INDEX MAY, 1988

ACETALDEHYDE -

This compound is highly volatile, biodegrades and was present in relatively small quantities. Unless it can be shown in volatile analyses, it is unnecessary to include this material.

ACETALDEHYDE OXIME -

This compound is highly volatile, hydrolyzes, very little was disposed.

ACETAMIDE -

The Army states the substance is short-lived in the environment. If the compound has not appeared in the environmental monitoring, it should be deleted.

ACETIC ACID -

Given the rapid biodegradation, the compound has no significance to remedial activities.

ACETOPHENONE -

Army states this compound is non-persistent. Is there sampling data to justify its inclusion despite a lack of information on quantity?

ACETYLENE -

This compound is extremely volatile, and hydrolyzes readily. The material was not a component of a waste stream, and the quantities attributed to disposal of this material are incorrect as this was lime, not acetylene. Significant relevant sampling data, or quantity data must be located to justify inclusion in light of the non-persistence of the compound.

ALDRITE 4 EC -

As a formulation, this is not a chemical compound appropriate for inclusion. Aldrin is included in the Index.

ALLYL CHLORIDE -

Given the rapid rate of hydroloysis and the inclusion of allyl alcohol in the Index, unless sampling data has shown its presence, it should be deleted.

ALUMINUM CHLORIDE -

Because this compound decomposes in water, it would not be persistent in the environment.

CALCIUM OXIDE -

Would only exist in the hydrated form, i.e., calcium hydroxide, from the manufacturing process.

CHLORINE -

Why is chlorine included? There is no need to include chlorine in the Index. Any impact from this material will be represented as HCl, NaCl, CaCl, etc. Bromine is correctly excluded from the Chemical Index.

CHLORACETYL CHLORIDE -

Not persistent, readily hydrolyzed, adequately covered by chloroacetic acid entry in Index.

CURING AGENT C-III, P, U, Z -

Since this is a trade name with no compound specific data, it should be removed.

CUTTING OIL ADDITIVE C-400 AND C-403 -

Since this is a trade name with no compound specific data, it should be removed.

1,2 DIBROMO 2,2-DICHLOROETHYL DIMETHYL PHOSPHATE

The rate hydrolysis is so high that this compound should be removed from the Index.

DICHLOROACETYL CHLORIDE -

Since it decomposes, has a short half-life, and none has been found in the environment, why is it included here?

DIKETENE -

This compound is "reactive in the environment, decomposes in water and volatile". Absent identification in sampling, there is not justification for its inclusion.

DIMETHYLAMINE -

"Highly volatile", rapidly degraded by microorganisms. Absent sampling identification should be deleted.

ETHYL BENZENE -

If there is no information in the History section, this compound should be deleted.

ETHYLENE -

This is a gas and not associated with soil or water contamination, and should be excluded.

KETENE -

This compound decomposes in water, is highly volatile and has a short half-life. The persistence criteria has not been met and as such the compound should be deleted from the Index.

HYDROCYANIC ACID -

As a highly volatile compound with a short half-life, the compound should be deleted unless identified in monitoring results. All cyanide wastewater produced by Shell was detoxified by treatment with sodium hypochlorite.

HYDROGEN PEROXIDE -

Given the environmental fate, reactivity, and tendency to decompose, this compound should be deleted unless identified in monitoring results.

ISOPROPYL ALCOHOL -

Given the rapid chemical decomposition and volatility, this compound is not relevant to remedial activities and should be deleted.

METHANOL -

The volatility and rapid biodegradation indicates removal of this compound from the Index.

METHYLAMINE -

Because of the compound's high volatility and rapid biodegradation, it should be removed from the Chemical Index.

METHYL-ISOCYANATE -

Decomposes in H_2O, therefore should be deleted from the Chemical Index.

2 METHYLLACTONITRILE -

Quickly decomposes to HCN and acetone. As these compounds are represented, there is no point in retaining this compound in the Index.

MONOCHLOROMETHANE -

As a gas it has no relevance to soil and groundwater contamination.

NITROGEN OXIDE -

Gas and has no relevance.

PARAFFIN -

Because of absence of toxicity, this substance should be excluded.

ATTACHMENT C

CHEMICALS RECOMMENDED FOR INCLUSION IN THE DRAFT RMA CHEMICAL INDEX MAY, 1988

In reviewing the Comprehensive List of Chemicals Included in the 1988 RMA Chemical Index (Table 1), we note several compounds that should have been included. In a study conducted by Morrison-Knudsen Engineers (Ranking of Chemical Compounds and Substances of Possible Significance at the Rocky Mountain Arsenal, December, 1986), which was previously provided and discussed with the Army, you will remember that a prioritization process was developed for chemicals of interest based on five rating factors:

- Toxicity
- Carcinogenicity
- Disposal Quantity
- Current Presence
- Environmental Persistence

Each of the chemicals has been assigned a rating of 1, 2, or 3 for each of the above factors. The arithmetic sum of the individual ratings for a chemical could give a maximum score of 15. We have reviewed Table 1 of the 1988 Draft Index and recommend that the following chemicals (which scored 11 or greater in the MKE ranking) should be included:

Asbestos
Benzyl chloride
Carbon disulfide
Chloroacetophenone
Dichlorobenzenes
m-Dinitrobenze
1,4-Dioxane
Ethylene dibromide
Formaldehyde
2-Hydroxybenzaldehyde
Polychlorinated biphenyls
Selenium
Sodium isopropylmethylphosphonate
Toxaphene

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
FISH AND WILDLIFE ENHANCEMENT
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IN REPLY REFER TO:

June 20, 1988

Colonel W.N. Quintrell
Deputy Program Manager
Department of the Army
U.S. Army Toxic and Hazardous
Materials Agency (USATHMA)
Building 4435
Aberdeen Proving Ground, Maryland 21010-5401

Dear Colonel Quintrell:

We have reviewed the three volume set Draft Final Rocky Mountain Arsenal Chemical Index with proposed chemical - specific ARARs. We do not have any comments relating to these documents at this time.

Sincerely,

Jeffrey D. Opdycke
State Supervisor

cc: Bob McCue, FWS
Tom Jackson, FWS
Bob Stewart, DOI
Connally Mears, EPA
Douglas Reagan, ESE

88321

Comments with Responses to the
May 1988 RMA Chemical Index

USEPA, REGION VIII COMMENTS TO THE MAY 1988 RMA CHEMICAL INDEX WITH RESPONSES

1. Under the category: History of use, production, disposal, and quantities, there are possible discrepancies between the information reported here and that contained in applicable CARs. For example, at Site 1-13, eight samples contained toluene concentrations ranging between 0.4 and 30 ppm; the majority of these were collected in the vicinity of building 514. The Phase I CAR for Site 1-13 does not provide a possible source for the observed toluene levels. However, the Chemical Index (this document) relates that 1,000 gallons of toluene were spilled at building 514 (in Site 1-13) in 1955. The source of historical information used in the Chemical Index should be better documented.

Response: The discrepancies noted for site 1-13 are due to the incomplete information included in an earlier version of the CAR which for this site was issued in 1986.

The statements concerning chemical history at RMA in the draft edition of the 1988 Chemical Index have been deleted. These historical summaries have been replaced by cross references to the CARs or to the Army's and Shell's interrogatory answers. (The Building CARs are not included in the cross-references because these documents have not been finalized at this time.)

2. The EPA reserves the right to comment in the future on specific applications of the Chemical Index. For example, future research may affect understanding of persistence or toxicity of many of the compounds in the index.

Response: EPA, Shell and the State will have further opportunities for review and comment on the specific application of the Chemical Index both in the context of the draft Endangerment Assessment Report and the draft Feasibility Study Report.

SHELL OIL COMPANY COMMENTS TO THE MAY 1988 RMA CHEMICAL INDEX WITH RESPONSES

General Comments (From June 16, 1988 Letter to Cpt. A. Kingery)

1. We have two major concerns relative to the contents of the Army's Chemical Index. First, we previously provided you with a study titled "Ranking of Chemicals, Compounds, and Substances of Possible Significance at RMA, December 1986," in which we developed a ranking system for toxicity and carcinogenicity of all compounds handled on the RMA. We believe this ranking system incorporates generally accepted classification of hazard. Therefore, we still believe this is a valid classification system and should be utilized.

Response: The toxicity information contained in this most recent version (August 1988) of the RMA Chemical Index has been revised. All existing data, except for the EPA carcinogenic classifications, have been removed and replaced by a toxicity score. The methodology for determining this score is given in Volume I, Introduction of the Index. Since this toxicity score methodology was used for the nontarget compounds (see Appendix C of May 1988) and no comments were received from Shell regarding this methodology, it has been adapted for all entries.

2. Second, we have significant concerns regarding the section of the Index titled "History of Use, Production, Disposal and Quantities." In the discussion portion of the Index, the authors explain that the information is not intended to be all-inclusive, but to "describe the relationship" of the compound to RMA activities. Also, the authors caution that the quantities presented are for comparison purposes and the available data are incomplete due to a lack of continuous record. We believe the Chemical Index should be a factual and accurate document due to its potential future use. We find that the Index contains numerous errors, especially in the history section.

   The history section contains information regarding waste quantities and spill information that is based on selected data, not the complete available record, and many of the entries appear to be biased, incomplete, and not applicable to the RI/FS. In addition, much of the information presented has little historical basis to substantiate its validity. What is important to remediation is what is extant in the environment today, which is the objective of the RI/FS.

Accurate records exist in the Shell answers to the U.S. interrogatories and in Shell's monthly/quarterly operating summaries on the quantities of raw materials utilized and products and dates of manufacture. Additional information exists in Army records, which have been provided to Shell, in which the Army could expand its history section to a more complete and accurate record of materials produced, used, and disposed of on the RMA.

Response: The existing history text given for each chemical entry has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

I. Comments on specific chemicals listed by primary name are located in Attachment A.

Acetamide	Nudrin production was from 1973 to 1982.

Response: This compound has been removed from the August 1988 version of the RMA Chemical Index.

Acetone	Army should also be listed on the information source.

Response: We agree and the information has been incorporated.

Acetylene	What is the value of listing two years disposal of waste lime to lime pits?

Response: This compound has been removed from the August 1988 version of the RMA Chemical Index.

Acetylene tetrachloride	Army should be listed as the source of information.

Response: We agree and the information has been incorporated.

Adamsite	Army should be listed as the source of information.

Response: We agree and the information has been incorporated.

Aerozine 50	If the two ingredients are listed as having a Sax rating of 3, why isn't the mixture rated as having a rating of 3?

Response: All Sax ratings were removed from this version of the RMA Chemical Index.

Akton	The material was not produced from 1952 to 1974, only in 1967.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Aldrin — Effluent to Basin A until 1957. Shell objects to the classification of this compound as a probable human carcinogen. A forthcoming dieldrin risk assessment will discuss the toxicological aspects of aldrin/dieldrin.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. The USEPA carcinogenicity classification system was used and is so referenced.

Aldrite 4EC — Under formula: this is a 4-pound per gallon emulsifiable concentrate of Aldrin in a solvent.

Response: This compound (formulation) has been removed from the August 1988 version of the RMA Chemical Index.

Allyl alcohol — This is not a raw material for the synthesis of DBCP.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Aluminum chloride — Wasn't this used in the production of thionyl chloride operations (see entry under aluminum hydroxide)?

Response: This compound has been removed from the August 1988 version of the RMA Chemical Index.

Aluminum hydroxide — Army should be listed as the information source.

Response: We agree and the information has been incorporated.

alpha-Amino-iso-butyronitrile The disposal period was 1970 to 1971.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Ammonia Army should also be listed as the information source.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. In addition, the Army has been listed as an information source.

Ammonium chloride Sold as a fertilizer in 1979 to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Ammonium nitrate Dates are not correct.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Arsenic Has the army analyzed its various fuel oil supplies for trace metals? There is no relationship between the arsenic contamination in Section 36 and RMA groundwater and the amount of arsenic found in Shell's No. 6 fuel oil.

Response: We agree that it is inappropriate to include arsenic detection in fuel oil; all notations to this have been removed from the entry.

Arsenic chloride The wells near Basin F are not the only place that the monitoring program has detected arsenic; also Section 36, and the South Plants areas.

Response: We concur that arsenic has been detected in areas other than the Basin F area; however, these detections are a result of the RI/FS and not the previous monitoring programs that this section addresses. In any case, the existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers or original references, as appropriate.

Azodrin This material was manufactured by Shell from 1965-1982. Information provided in the history section is particularly biased, incomplete and not applicable to the RI/FS.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Benzene Benzene was not used past 1957 in aldrin, dieldrin, and endrin manufacture. Where is the data on the Army's usage of this material? Why doesn't the information sources list lessee prior to Shell as benzoyl peroxide does?

Response: The existing history text has been removed and substituted with references to white-cover CARs. According to Shell's response to Interrogatory #14, benzene was used until 1965 in endrin production and until 1964 in dieldrin production. It also has been determined that Colorado Fuel and Iron (CF&I) also used benzene; entry has been changed accordingly.

Benzothiazole We do not believe this compound was present in any Shell pesticides.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Bicyclopentadiene (DCPD)	Since dicyclopentadiene has been the traditional nomenclature for this compound on the RMA, we recommend we continue its use. The disposal period did not extend past 1974. Monitoring history includes information on the Army's estimate of the size of a plume. What determines when the Army describes the size of a plume? Has this been done for all compounds? How does the Army know the origin of the plume described; i.e., how do they know if the material came from any particular place in Basin F, versus either the sanitary sewer, chemical sewer, or from Basin A?

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. The primary name has been changed to dicyclopentadiene and the monitoring history section has been edited to remove notations of plume size.

Bis-carboxymethyl sulfone	Army should be listed as the source of information.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. No information has been located to list the Army as the source of information.

Bis-carboxymethyl sulfoxide	Army should be listed as the source of information.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. No information has been located to list the Army as the source of information.

Bis(2-chlorovinyl) chloroarsine	If the toxicity is comparable to Lewisite, why is there no toxicity rating?

Response: This a qualitative assessment based on structure; this statement has been removed and no quantitative data have been located.

Bromic acid, potassium salt — Shell did not handle potassium in the Dibrom or Nemagon process. Hence, it would not have been possible to generate this material as indicated.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. We agree and Shell has been removed as the information source.

2-Butoxyethanol — This is a common ingredient in automotive antifreeze solutions. Hence, both Shell and the Army should be listed as information sources.

Response: We agree that both the Army and Shell should be listed as information sources but not because of antifreeze use. 2-Butoxyethanol was used by Shell in its pesticide production and by the Army in the mustard demil and GB operations.

Cadmium — Army sites have been found to contain cadmium. The Army should be listed as a source of information.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. In addition, the Army has been listed as a source of information.

Calcium bromate — This material was not part of an effluent stream as suggested by the Army. Calcium was not incorporated as part of a neutralization agent by Shell in the manufacture of Nemagon. Shell should not be listed as an information source.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. Calcium bromate was detected in a Shell vent gas burner, and as a result, Shell will continue to be listed as an information source.

Calcium chloride	Also used by Army and Shell as road deicer; hence both parties should be listed as information sources.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. We agree that both the Army and Shell may have used calcium chloride as road deicer; however, the amounts are small when compared to overall historical usage. Both parties have been listed as sources of information. The Army used calcium chloride in the phosgene and GB operations; Shell used calcium chloride in its pesticide productions.

Carbon tetrachloride	Army should also be listed as the source of information.

Response: We agree and the information has been incorporated.

Chloral hydrate	This material did not go to Lowry as indicated.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Chlordane	The reference to Julius Hyman should be changed to Shell.

Response: We agree and the information has been incorporated.

Chlorinated paraffin	Should reference the disposal on the RMA in the laundry effluent.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Chlorinated phenol Unless more definitive information is available, the information source should not list Shell.

Response: The existing history text has been removed and substituted with references to white cover CARs, Army and Shell interrogatory answers, or original references, as appropriate. The reference citing Shell usage has been reviewed, and the information confirmed; Shell will continue to be listed as the information source.

Chloroacetaldoxime The time period should be from 1973 to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Chloroacetic acid This is a decomposition product of mustard. The Army should be listed as the source of information.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. We agree, the Army has been listed as the source of information.

Chloroform The history of Shell usage should extend to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

2-Chlorovinyl arsonic acid Change "Assignment" to "Information Source".

Response: We agree and the heading has been changed.

2-Chlorovinyl arsonous acid	Army should be listed as the source of information.

Response: No site-specific data are available; the entry has been deleted.

Chromic Acid	Change "Assignment" to "Information Source". Army should be listed as the source of information.

Response: We agree and the heading has been changed, and the Army has been listed as the source of information.

Copper	Army should be listed as the source of information (see copper sulfate - history).

Response: We agree and the information has been incorporated.

Cyclohexanone	Shell never disposed of this material in Lake Mary.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

1,3-Cyclopentadiene	It was also used in endrin manufacture.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

DDVP	This is not a process intermediate during Bidrin manufacture.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

1,2-Dibromo-chloropropane What is meant that contamination is above standard in Section 13? Shell objects to the classification of this compound as a probable human carcinogen. Toxicological information is available in a risk assessment previously provided by Shell.

Response: Statement regarding contamination above standard will be deleted. The USEPA carcinogenicity classification scheme was used and is so referenced.

1,1-Dibromoethane If this material was used on the RMA, the Army should be listed as the information source.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. However, no information was located to list the Army as the information source.

2,2-Dichloro-acetaldehyde Shell should be listed as the information source.

Response: We agree and the information has been incorporated.

1,2-Dichloroethane We do not believe Shell was involved with this chemical. Therefore, the Army should be listed as the information source.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. The information used to list Shell as the information source has been reviewed (very small amounts were used); Shell has been deleted as the information source. No information has been located to list the Army as the information source. Hence, the information source heading has been changed to state "not assigned."

1,1-Dichloroethylene	This product was not handled by Shell. Therefore, the Army should be listed as the information source.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. No information has been located to list either the Army or Shell as the information source. Hence, the information source heading has been changed to state "not assigned."

Dieldrin	The disposal quantity is overstated. A synonym is 497. Shell objects to the classification of this compound as a probable human carcinogen. A forthcoming risk assessment will discuss the toxicological aspects.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. The USEPA carcinogenicity classification system was used and is so referenced. The synonym information has been included.

O,O-Diethylphosphorochloridothioate	A synonym for this compound is Ethyl thio acid chloride (Ethyl TAC). The years of manufacture are 1964 to 1966.

Response: The synonym information has been incorporated. The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

O,O-Diethyl thionophosphonate	The formula is $C_4H_{11}O_3PS$.

Response: The information has been incorporated.

2-(Diisopropylamino) -n-ethyl sulfonate	The Army should be listed as the information source.

Response: We agree and the information has been incorporated.

Diketene	This compound was also used in the manufacture of Bidrin.

Response: This compound has been removed from the August 1988 version of the RMA Chemical Index.

Dimethano-naphthalene	The formula is $C_{12}H_{14}$.

Response: The information has been incorporated.

Dimethyl arsenic acid	The Army should be listed as the information source.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. Because of the uncertainty of the compounds association with Lewisite operations, the information source heading will state "not assigned." However, the potential association with Lewisite is given in the history section.

Dimethylmercury salts	The Army should be listed as the information source.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. Because of the uncertainty of the compounds association with Lewisite operations, the information source heading will state "not assigned." However, the potential association with Lewisite is given in the history section.

Dimethylnitrosamine	This material should be listed as a possible decomposition product of hydrazine. Refer to Army decision document on the closure of the hydrazine facilities.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

O,O-Dimethyl-phosphoro chloridothioate	A synonym for this material is Thio Acid Chloride (TAC). ETAC is the synonym for Ethyl Thio Acid Chloride.

Response: The information has been incorporated.

Di-n-propyl-nitrosamine	If there is no information in the History section, this compound should be deleted.

Response: No information has been located at this time. However, since it is a soil target analyte, it is included in the Index.

Endrin	A synonym is 269. This was in the Army's inventory in the late 1970s as "Rid-a-Bird." Hence, the Army should be added as an information source.

Response: The synonym information has been incorporated. The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. We agree that the Army had "Rid-a-Bird" in its inventory. However, the quantities used are insignificant compared to Shell's 10 year production of endrin. The predominant user is Shell and Shell is more familiar with the compound. Shell will continue to be listed as the information source.

Fluoroacetic acid This is a decomposition product of G.B. The Army should be listed as the source of information.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. No information is available to indicate that fluoroacetic acid is a decomposition product of GB. Additional information from Shell would help identify the information source.

HCCPD impurities Groundwater monitoring data suggest that the wastes are not migrating from the burial site.

Response: The RMA Chemical Index presents basic data and no interpretations of data; hence it is inappropriate to give this statement.

Heptane Was used in the manufacture of Endrin.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

1,2,3,4,7,7-Hexachlorobicyclo (2.2.1)hepta-2,5-diene A synonym for this compound is 601.

Response: The information has been incorporated.

Hexachlorobutadiene	The reference to Shell's leasehold in the Monitoring history should be replaced with South Plants area. The "Shell leasehold" is a disputed Army term which has not been legally established.

Response: The information has been incorporated.

Hexachlorocyclopentadiene	The synonym for this is Hex. It is a raw material, not a process intermediate.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. The synonym information has been incorporated.

Isodrin	A synonym is 711.

Response: The information has been incorporated.

Lead	Considering that the Army handled munitions containing lead azide, the Army should be listed as the information source.

Response: The information has been incorporated.

Methane dichloride	Comments under History section are incorrect in that Shell was the contractor for the Army process and Army was owner of materials. Shell did use methylene chloride for a few years in the early 1960s as a solvent in the Azodrin process. Hence, Army should also be listed as an information source.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. The Army has also been listed as an information source for their use of methane dichloride as a heat transfer agent. Shell will continue to be listed as an information source since they handled the compound and should be familiar with it.

Methanethiol — The comment under the History section relative to disposal at Lowry is incorrect and needs to be retracted. Disposal dates for Basin F are 1973-1977.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Methanethiol, sodium salt — The comment under the History section relative to disposal at Lowry is incorrect and needs to be retracted. Disposal dates for Basin F are 1973-1977.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

N-Methylaceto-acetamide — Material was used 1965-1982. Disposal off the RMA is not applicable to the RI/FS; hence, this comment should be removed.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Methylamine — The period of use was 1965 to 1982.

Response: This compound has been removed from the August 1988 version of the RMA Chemical Index.

Methylarsonic acid Change "Assignment" to "Information Source." Since this compound is associated with Lewisite, shouldn't the Army be listed as the information source?

Response: We agree and the heading has been changed. Because of the uncertainty of the compounds association with Lewisite operations, the information source heading will state "not assigned." However, the potential association with Lewisite is given in the history section.

Methyl isocyanate The use period should be extended from 1975 to 1982.

Response: This compound has been removed from the August 1988 version of the RMA Chemical Index.

Methylmercury salts The Army should be listed as an information source.

Response: Because of the uncertainty of the compounds association with Lewisite operations, the information source heading will state "not assigned." However, the potential association with Lewisite is given in the history section.

Methyl phosphonic acid, isopropyl ester Since the Army used this material, why isn't the Army listed as an information source?

Response: We agree and the information has been incorporated.

Methyl phosphonic dichloride The History section should reflect that Shell was only a contract operator of the Army process using Army materials.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Methylthioacetaldoxime	The period of use should be extended from 1975 to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Monomethyl chloroacetoacetamide	The period of use should be extended from 1975 to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Monomethyl dichloroacetoacetamide	The period of use should be extended from 1975 to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

4-Nitrophenol sodium salt	A synonym is PNSP. This is a raw material for the manufacture of ethyl and methyl parathion.

Response: The synonym information has been incorporated. The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

3-Oxo-butanoic acid	The use period should be extended from 1975 to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Paint Thinner — We recommend this be dropped. Shell may have used incidental quantities. If paint thinner qualifies for inclusion, the Army should be listed under all chemicals with incidental usage, including a variety of pesticides.

Response: We agree; the entry has been removed from Index.

Pentachlorophenol — We are not aware of this chemical in our manufacturing processes.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. We agree that the compound is not associated with Shell operations.

Peroxyacetic acid — This material was used prior to 1952 in dieldrin and endrin manufacture. After 1952 the material was formed in-situ and in the epoxidation reactions, and not isolated.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Peroxybenzoic acid — We do not believe this material was used in the manufacture of endrin.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

alpha-Phenethyl alcohol — Should this be spelled: alpha-phenylethyl alcohol?

Response: We agree; the entry has been corrected.

Phosgene — We do not believe this is a decomposition product of Dibrom. Shell should be removed from the information source listing.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. We agree the compound is not a decomposition product of Dibrom, and Shell has been removed from the information source listing.

Photodieldrin — In published work on Dieldrin photolysis in the gas phase Crosby and Moilanen (Crosby, D.G., and Moilanen, K.W., "Vapor-phase Photo-decomposition of Aldrin and Dieldrin." Arch. Environ. Contam. Toxicol, 2:62, 1974) observed a Photodieldrin half-life of approximately ten days under artificial ultraviolet light. Photodieldrin removal reactions are probably dominated by a hydroxyl-initiated oxidation reaction sequence, as are those of most organic compounds, with reaction half-lives of 0.1 to 10 days (Darnell, et al, 1970). Thus, photodieldrin would be expected to have a very short atmospheric lifetime.

Response: The information has been incorporated.

Shell nitrogen solution — A synonym is 8-0-0-1S.

Response: The synonym has been incorporated.

Shell poultry spray — The product contained Rabon Insecticide, xylene, phenol, and an emulsifier.

Response: The information has been incorporated.

Sodium — The reference primary name should be sodium ion to avoid confusion with elemental sodium.

Response: We agree and the primary name has been changed.

Sodium carbonate The reference to off-site disposal should be removed from the text since it contributes nothing to the EA.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Sodium chloride The reference to off-site disposal should be removed from the text since it contributes nothing to the EA.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Sodium hydroxide Shell used this material as a process material in many of its processes to neutralize various materials. The reference to off-site disposal should be removed from the text since it contributes nothing to the EA.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Sodium hypochlorite Used by Shell to destroy cyanide containing wastes.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Sodium sulfate The reference to off-site disposal should be removed from the text since it contributes nothing to the EA.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Sodium sulfite The reference to off-site disposal should be removed from the text since it contributes nothing to the EA.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Sodium thiosulfate The Army agreed earlier to not list laboratory reagents due to the relatively small nature of any disposal. Therefore, this should be deleted.

Response: All Compounds specifically referenced as a RMA laboratory reagent were deleted; this compound was not so referenced. The entry information was confirmed. Three hundred pounds of Sodium thiosulfate were disposed in February 1962. The entry has not been deleted.

Sulfonic acid This is not the correct name for this compound.

Response: The compound is referenced as Sulfonic acid in Shell's response to U.S. Interrogatory #15. The information contained in the response is correct except for the formula; it has ben corrected to read SO_2OH

Sulfur dioxide Azodrin manufacture should be extended from 1975 to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Sulfuric acid Shell used this material also in the manufacture of dieldrin, endrin, and DDVP.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. Shell has been added as a source of information.

Tetrahydrofuran Purchased as a laboratory reagent. Should be removed from the listing since laboratory reagents by agreement are not to be included.

Response: All compounds specifically referenced as a RMA laboratory reagent were deleted. This compound was not so referenced; however, we agree and it has been removed.

Thionyl chloride Shell does not believe this material was used by Shell. The references are Army and not Shell. Where is the Army's basis for believing Shell used this material?

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. We agree that thionyl chloride is not associated with Shell operations and as a result, Shell has been remvoed as an information source.

Trichloroacetic acid Shell never produced Dursban; hence, this must be an Army chemical.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate. We agree Shell never produced Dursban and Shell has been removed as the information source. However, no information is available to list the Army as the information source.

2,2',4'-Trichloroacetophenone The formula is $C_8H_5Cl_3O$.

Response: The information has been incorporated.

2,2',5'-Trichloro-acetophenone The formula is $C_8H_5Cl_3O$.

Response: The information has been incorporated.

2,4',5'-Trichloro-acetophenone The formula is $C_8H_5Cl_3O$.

Response: The information has been incorporated.

2,4,6-Trichloro-triazine The information listed in the environmental fate is wrong. Cyanuric chloride reacts very rapidly with water and moisture in the environment, and is not stable in the environment.

Response: The data were reviewed, and we agree information was incorrect; the entry was revised as necessary.

Trimethyl phosphate The period of use should be extended from 1975 to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Trimethyl phosphite The period of use should be extended from 1975 to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Urea The period of use should be extended from 1975 to 1982.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Xylene — This material was not used in the manufacture of endrin. Xylene was used in methyl parathion manufacture.

Response: The existing history text has been removed and substituted with references to white-cover CARs, the Army's or Shell's interrogatory answers, or original references, as appropriate.

Zinc — If this was used only as a laboratory reagent, shouldn't it be deleted from the list?

Response: All compounds specifically referenced as a RMA laboratory reagent were deleted; this compound was not so referenced.

II. A list of chemicals recommended for removal from the Index are located in Attachment B with supporting comments.

Acetaldehyde This compound is highly volatile, biodegrades and was present in relatively small quantities. Unless it can be shown in volatile analyses, it is unnecessary to include this material.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Acetaldehyde oxime This compound is highly volatile, hydrolyzes, very little was disposed.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Acetamide The Army states the substance is short-lived in the environment. If the compound has not appeared in the environmental monitoring, it should be deleted.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Acetic acid Given the rapid biodegradation, the compound has no significance to remedial activities.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Acetophenone Army states this compound is non-persistent. Is there sampling data to justify its inclusion despite a lack of information on quantity?

Response: No sampling data are available and as a result it has been deleted from this version of the Index.

Acetylene — This compound is extremely volatile, and hydrolyzes readily. The material was not a component of a waste stream, and the quantities attributed to disposal of this material are incorrect as this was lime, not acetylene. Significant relevant sampling data, or quantity data must be located to justify inclusion in light of the non-persistence of the compound.

Response: No additional data are available and as a result it has been deleted from this version of the Index.

Aldrite 4 EC — As a formulation, this is not a chemical compound appropriate for inclusion. Aldrin is included in the Index.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Allyl chloride — Given the rapid rate of hydrolysis and the inclusion of allyl alcohol in the Index, unless sampling data has shown its presence, it should be deleted.

Response: No additional data are available and as a result it has been deleted from this version of the Index.

Aluminum chloride — Because this compound decomposes in water, it would not be persistent in the environment.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Calcium oxide — Would only exist in the hydrated form, i.e., Calcium hydroxide, from the manufacturing process.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Chloroacetyl chloride	Not persistent, readily hydrolyzed, adequately covered by chloroacetic acid entry in Index.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Chlorine	Why is Chlorine included? There is no need to include chlorine in the Index. Any impact from this material will be represented as HCl, NaCl, CaCl, etc. Bromine is correctly excluded from the Chemical Index.

Response: We agree with the comment given for the compounds' removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Curing agent C-III, P, U, Z	Since this is a trade name with no compound-specific data, it should be removed.

Response: We agree with the comment given for the compounds' removal from the RMA Chemical Index and as a result they have been deleted from this version of the Index.

Cutting Oil Additive C-400 and C-403	Since this is a trade name with no compound specific data, it should be removed.

Response: We agree with the comment given for the compounds' removal from the RMA Chemical Index and as a result they have been deleted from this version of the Index.

1,2 Dibromo-2,2-dichloroethyl dimethyl phosphate	**The hydrolysis rate is so high that this compound should be removed from this Index.**

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Dichloroacetyl chloride	**Since it decomposes, has a short half-life, and none has been found in the environment, why is it included here?**

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Diketene	**This compound is "reactive in the environment, decomposes in water and volatile." Absent identification in sampling, there is no justification for its inclusion.**

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Dimethylamine	**"Highly volatile," rapidly degraded by microorganisms. Absent sampling identification should be deleted.**

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Ethyl benzene	**If there is no information in the History section, this compound should be deleted.**

Response: Ethyl benzene is a target analyte for the soil and ground-water studies of the RI. All target analytes are included in the Index.

Ethylene — This is a gas and not associated with soil or water contamination, and should be excluded.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Ketene — This compound decomposes in water, is highly volatile and has a short half-life. The persistence criteria has not been met and as such, the compound should be deleted from the Index.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Hydrocyanic acid — As a highly volatile compound with a short half-life, the compound should be deleted unless identified in monitoring results. All cyanide wastewater produced by Shell was detoxified by treatment with Sodium hypochlorite.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Hydrogen peroxide — Given the environmental fate, reactivity, and tendency to decompose, this compound should be deleted unless identified in monitoring results.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Isopropyl alcohol — Given the rapid chemical decomposition and volatility, this compound is not relevant to remedial activities and should be deleted.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Methanol — The volatility and rapid biodegradation indicates removal of this compound from the Index.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Methylamine — Because of the compound's high volatility and rapid biodegradation, it should be removed from the Chemical Index.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Methyl-isocyanate — Decomposes in water, therefore should be deleted from the Chemical Index.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

2-Methyllactonitrile — Quickly decomposes to HCN and acetone. As these compounds are represented, there is no point in retaining this compound in the Index.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Monochloromethane — As a gas it has no relevance to soil and groundwater contamination.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Nitrogen oxide Gas and has no relevance.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

Paraffin Because of absence of toxicity, this substance should be excluded.

Response: We agree with the comment given for the compound's removal from the RMA Chemical Index and as a result it has been deleted from this version of the Index.

III. A list of chemicals recommended for inclusion in the Index are located in Attachment C

In reviewing the Comprehensive List of Chemicals Included in the 1988 RMA Chemical Index (Table 1), we note several compounds that should have been included. In a study conducted by Morrison-Knudsen Engineers (Ranking of Chemical Compounds and Substances of Possible Significance at the Rocky Mountain Arsenal, December, 1986), which was previously provided and discussed with the Army, you will remember that a prioritization process was developed for chemicals of interest based on five rating factors:

- Toxicity
- Carcinogenicity
- Disposal Quantity
- Current Presence
- Environmental Persistence

Each of the chemicals has been assigned a rating of 1, 2, or 3 for each of the above factors. The arithmetic sum of the individual ratings for a chemical could give a maximum score of 15. We have reviewed Table 1 of the 1988 Draft Index and recommended that the following chemicals (which scored 11 or greater in the MKE ranking) should be included:

Asbestos
Benzyl chloride
Carbon disulfide
Chloroacetophenone
Dichlorobenzenes
m-Dinitrobenzene
1,4-Dioxane
Ethylene dibromide
Formaldehyde
2-Hydroxybenzaldehyde
Polychlorinated biphenyls
Selenium
Sodium isopropylmethylphosphonate
Toxaphene

Response: Of the 14 chemicals listed, 2 have been added to this version of the Chemical Index because of the availability of historical data; they are chloracetophenone and formaldehyde. Of the remaining 12, six were included in the 1986 Index but had been subsequently removed; the reason for their removal from the current Index is given on Table A-1. These six compounds are asbestos, carbon disulfide, m-dinitrobenzene, polychlorinated biphenyls, selenium and toxaphene. Two compounds listed are currently in the Index. They are dichlorobenzenes as p-dichlorobenzene, and sodium isopropylmethylphosphonate as isopropyl methyl phosphonate. We have no historical data to support the inclusion of the remaining four compounds (benzyl chloride, 1,4-dioxane, ethylene dibromide, and 2-hydroxybenzaldehyde).

IV. Miscellaneous comments:

1. Page 4, Criteria #1 - There are no specifics provided to interpret the proposed definition of "large quantities."

Response: A qualitative assessment of quantities (based on limited available data) was used for the original selection of the analytes; however, this criterion is no longer important for the RI target analytes.

2. Page 5, first paragraph - The statement in the third sentence lacks specificity. If it is not defined elsewhere in the text, it should be clarified, or removed. What is meant by "not obviously benign?"

Response: The statement "not obviously benign" relates to the apparent toxicity of a chemical. For example, an oral dose value greater than 5,000 mg/kg would characterize the chemical as benign.

3. Page 5, first paragraph - The last sentence overlooks that some technical aspects of the remedial program may well involve volatilization. Hence, volatilization should be considered.

Response: Volatilization is significant to the remedial program but was not considered as a pathway of contaminant dissipation from soil or ground water in developing persistence criteria.

4. Page 16, History of use, production, disposal and quantities - The history section contains information regarding waste quantities and spill information that is based on selected data, not the complete available record, and many of the entries appear to be biased, incomplete, and not applicable to the RI/FS. In addition, much of the information presented has little historical basis to substantiate its validity. What is important to remediation is what is extent in the environment today, which is the objective of the RI/FS. Accurate records exist in the Shell answers to the U.S. interrogatories and in Shell's monthly/quarterly operating summaries on the quantities of raw materials utilized and products and dates of manufacture.

Response: The statements concerning chemical history at RMA in the draft edition of the 1988 Chemical Index have been deleted. The historical summaries have been replaced by cross references to the CARs or to the Army's and Shell's interrogatory answers. (The Buildings CARs are not included in the cross-references because these documents have not been finalized at this time.)

5. Page 10, Environmental Fate - The information provided in this section should be qualified because of the limitations inherent in the data and the references used to determine the environmental fate. Wide variations in conclusions can be drawn from the literature. For example, the conditions of persistence and degradation vary considerably depending on conditions of their deposition and environmental factors. Additionally, the environmental fate should provide meaningful information. Some sections have not, e.g., lead.

Response: We agree that the data provided under the Environmental fate heading should be qualified; the text has been revised accordingly.

6. Page 11, Toxicity - The toxicity ratings proposed place many compounds in severe classification, which does not relate to what the public is familiar with as pertains to Class B poisons. The MKE system proposed earlier (Ranking of Chemicals, Compounds, and Substances of Possible Significance at the RMA, December 1986) utilizes widely accepted definitions and is based upon more readily available LD/50 values. There are many compounds for which the Army has not located a Sax rating, illustrating the inadequacy of the approach selected. Why is there more than one Sax rating on chemicals?

The response to Shell's comment Number 24 (see Appendix B - response to 1986 RMA Chemical Index) indicates the Army's wish not to interpret which toxicity data to list, if there is more than a single source, which can easily be resolved. We could agree on which data is most representative of the concern for remediation on the RMA and note it accordingly. Most of the data is going to fall within some prescribed area as indicated on the MKE report of ranking of chemicals. In some cases, it may fall into two areas as the Sax rating does. This should not present the problem envisioned. As it currently stands, the Sax data base is incomplete and also has many missing data points.

Response: The Sax rating has been removed from all entries, and has been replaced by a toxicity score derived from LD_{50} values. The methodology used for the toxicity scores is given in the Introduction.

7. Table 2, page 6 - Shell has a certified method available for trimethyl phosphate. (See note #6).

Response: Trimethyl phosphate was a candidate compound for site-specific investigations in the Phase II RI program which was not selected for further study. The compound was not found as a nontarget analyte in Phase I. While it might be possible to certify Shell's method, it has not been tested by the USATHAMA QA Program (see also letter from Donald Campbell OPM/RMA, to Edward McGrath, HRO, dated August 4, 1987, concerning analytical methodologies).

8. Appendix A, page 2 -

First Bullet - If physical materials are excluded, such as asbestos, where is this information to be listed?

Second Bullet - There are many duplications in the text that according to this item should be eliminated. For example, sulfate is a duplicate of many of the salts listed.

Fifth Bullet - There are several entries that are laboratory reagents as noted in the comments above.

Response: Most of the information regarding Asbestos and other physical materials may be found in Buildings RI Report - Task 24 Structures Survey, June 1988. Volume I of the Buildings Report contains summary information of sampling frequency, survey results, and volume estimates of various physical materials including Asbestos. Volume II of the report contains structure specific information in detail. Additional information may be obtained in the contamination assessment sections of the CARs. This information will be supplemented and analyzed further in the forthcoming SARs.

Some anions (e.g. sulfate) may be seen as a duplicate entry but this is due to the fact that the anion is part of the RI analytical suite; all target analytes are listed in the Index.

Originally all compounds specifically related to RMA laboratory agents were removed. Those listed in Attachment A were not so noted; however, we have removed tetrahydrofuran from the Index.

U.S. DEPARTMENT OF THE INTERIOR - FISH AND WILDLIFE SERVICE COMMENTS TO THE MAY 1988 RMA CHEMICAL INDEX WITH RESPONSES

The U.S. Department of the Interior - Fish and Wildlife Service reviewed the document and had no comments.